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THE ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

MAY 11, 1939

Building a rolled-fill core as part of Fort Peck Dam slide repair

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THIS WEEK

- The long awaited report on what caused the slide that badly damaged Fort Peck Dam last fall is given in the leading article in this issue. The report is made more understandable by a brief description of the dam and of the slide prepared for *ENR* by the Army Engineers.

- Following the Fort Peck report is a description of the reconstruction work now in progress at the dam prepared by H. W. Richardson of the *ENR* staff following a visit to the dam.

- A network of toll roads criss-crossing this country will not pay, according to engineers of the Bureau of Public Roads in a report recently submitted to Congress. The report is summarized in this issue. The bureau engineers say that what is needed is an expansion and improvement of our present system of inter-regional highways.

- Freezing ground to form cofferdams is an old trick in Europe but is little known here. Engineers of the TVA tried it with success for a small cofferdam at Gilbertsville. The system they used and their costs are given in this issue.

THINGS TO COME

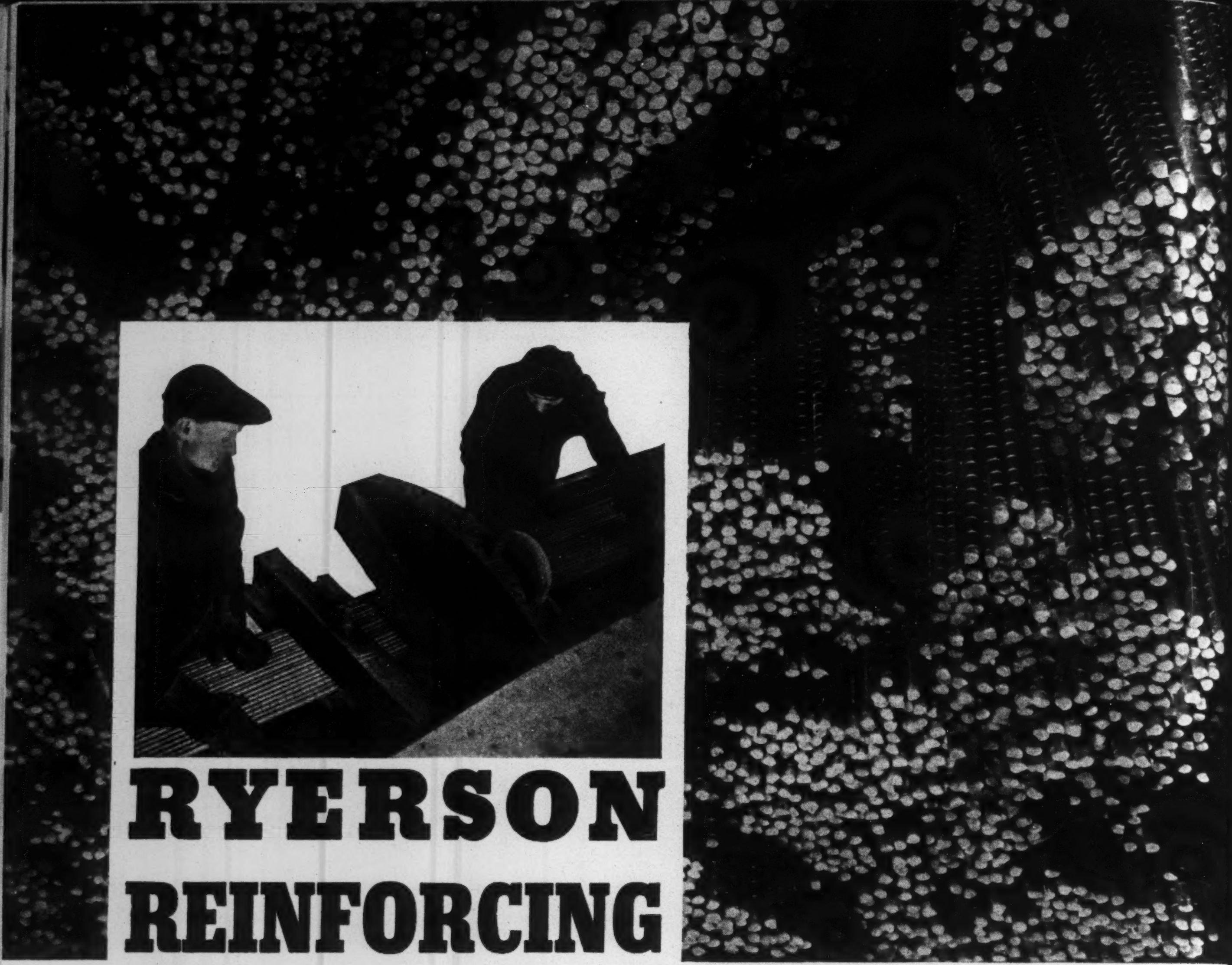
- A man familiar with blasting practices tells how to handle blasting operations to get the most out of the men and materials. Here is a practical article for contractors.

- New designs for roller gates have resulted in more efficient gates and fewer operating troubles. An article soon to be published gives the fundamentals.

- Practical experience in highway lighting confirms conclusions drawn from laboratory studies reported in these pages in October, 1937.

- Seattle has begun the construction of Ruby Dam to augment its power system. The dam is to be built in stages, ultimately reaching a height of 653 ft.

COMING JUNE 8, THE ANNUAL WATERWORKS NUMBER.



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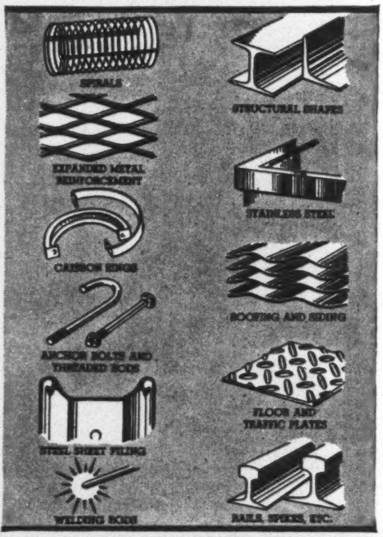
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NEWS

ENGINEERING NEWS-RECORD

Volume 122 MAY 11, 1939 Number 19

WPA Approved By Localities

Survey reveals states think projects valuable, but program does not cover all needy

General approval of the present WPA program was voiced by local communities throughout the country which cooperated in a survey undertaken by the National Appraisal Commission, an organization made up of representatives from the WPA, the Bureau of Public Roads, the American Engineering Council, and various other organizations interested in planning and public welfare (*ENR*, Feb. 17, 1938, p. 279).

In each state the Appraisal Committee asked some state organization, such as the state league of municipalities, planning board, or state university to gather from state or local officials answers to a series of questions concerning the works program. Afterward the answers were summarized in each state by a committee of leading citizens. The final appraisal covered 42 states and involved about 8,000 state and local reports.

Of all the communities which specifically answered the questions, 93 per cent said that the work done was needed and of benefit and 90 per cent that it was of permanent value. Work relief was better than a dole, both for the individual and for the community, in the opinion of 90 per cent, and a similar percentage approved of the nonconstruction projects.

The quality of the workmanship was good in the opinion of 85 per cent of

(*Continued on p. 49*).

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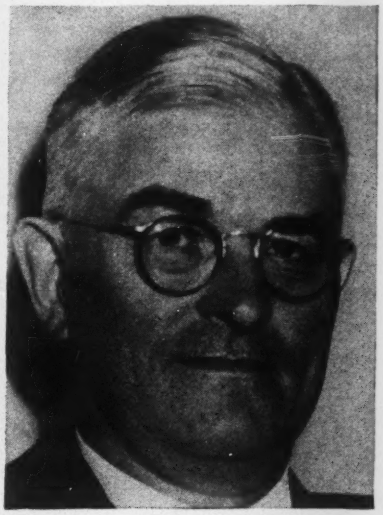
Maryland Eliminates Engineer Department

A bill abolishing the Maryland state engineering department has been signed by Governor O'Connor. This action eliminates the positions of state engineer and senior and junior assistant state engineers. The work formerly done by the department will be handled by the state health department and the Maryland public service commission.

Elimination of the engineering department was recommended by a special commission appointed to suggest changes in the state organization.



Banks to Be Chief At Bonneville

Frank A. Banks, construction engineer of the Grand Coulee Dam project, was appointed on May 4 to the position of acting administrator of the Bonneville project to succeed the late J. D. Ross. While acting as administrator at Bonneville, Banks will continue at Grand Coulee.

Appointed as assistant administrator was Barry Dibble, consulting electrical engineer for the Indian Service.

Banks, who is 57, is a graduate of the University of Maine and has been employed continuously by the Bureau of Reclamation since 1906. In 1917 he was made construction engineer of the American Falls Dam in Idaho, and in 1920 he became construction engineer on the Owyhee Dam in Oregon. He has been construction engineer at Grand Coulee since the project was begun in 1933. For the past several years he has been a member of the three-man advisory board which has been working with the Bonneville administrator.

Big Appropriation For Reclamation

Congress allots $63,000,000—more than ever before—for reclamation projects

The Department of Interior bill, recently passed, carries the largest amount of money ever appropriated by Congress for reclamation purposes. The bill provides about $63,000,000 to be used on reclamation projects, as compared with about $40,000,000 allotted the Reclamation Bureau last year. This year, the reclamation program is cared for in the regular appropriation, while last year emergency funds were largely used.

It is understood that of the funds to be made available for the new fiscal year beginning July 1, the largest portion will be used to continue construction work on reclamation projects already under way. However, it also means that new contracts will be let for numerous jobs.

An important item in the reclamation measure for the coming year provides $5,000,000 for many small projects in the Great Plains area. This money is made available to the President for allotment to these projects, which include the states of North and South Dakota, Wyoming, and Nebraska embraced in the Great Plains drouth area. A similar appropriation was contained in last year's emergency appropriation, but Congress at that time threw such restrictions around the use of the money that it was not found practicable to start the work. These restrictions have been eliminated in the present measure, and plans for the construction work on this project are now being drawn.

In the second deficiency bill, which has already been passed and signed, there is an item of $4,000,000 for construction of a transmission line from Parker Dam (between California and Arizona) to Phoenix, Ariz., and for the commencement of a power house at Parker Dam. The Bureau of Reclamation will shortly advertise for bids for construction of the transmission line. The power plant will be built by government forces rather than by contract.

Klinger Hits WPA At C. of C. Meeting

Says its competition with private industry is major obstacle to recovery

Highlight of the annual meeting of the U. S. Chamber of Commerce held at Washington May 1-4 was a vigorous attack on the WPA by W. A. Klinger, Sioux City contractor and former president of the Associated General Contractors. Klinger called the WPA one of two major retardants of recovery, in which he included investment fear and government competition. Competition of the WPA with the construction industry was described as the largest item of government competition.

Klinger characterized many WPA activities as "imitation construction operations", and then paid his respects to the Council of Mayors and other politician groups in the following statement:

"More and more the nation, once highly resentful of this organized loafing, has come to believe that the WPA is a necessary evil and has unfortunately become tolerant of it. More and more the local politicians, the Council of Mayors, the Conference of Governors, finding in the WPA the opportunity to relieve their own charity list, have become strong advocates of increased appropriations, and unfortunately for the construction industry and for the nation as a whole they have found a willing ear".

Klinger also spoke of the WPA as "an organization which is straining at the leash to build monuments, to do the nation's public-works construction without the use of regular channels of business, without any sense of economy, without the use of private construction organizations, but by the socialization of one of the nation's major industries", and he declared that the volume of work taken away from private industry is the open boast of the organization.

In place of the WPA, Klinger advocated a regular program of genuinely useful public works let to private enterprise by contract, the contractors to hire their own labor and to get real work out of this labor. As for the remaining unemployed, he urged that they be taken care of by home relief, with such federal assistance as may be necessary, and that they be encouraged to get off relief by making it easy to get back on relief when their sources of employment fail.

Much construction waiting

Finally, Mr. Klinger pointed out that more construction is waiting to be done than has been done in the last century, all of which would make for a happier and more contented citizenry, and he urged that the construction industry be given a chance to serve. This point was emphasized also by L. R. King, Lincoln, president of the Iowa-Nebraska Light & Power Co. King estimated that the utilities would make capital expenditures of a billion dollars a year for the next three years if the government took a favorable attitude to them. For the current year he estimated an expenditure equal to that of 1938, which was $433,000,000. To demonstrate deficiencies in the nation's power plant he stated that between 1929 and 1938 installed capacity increased by only 20 per cent (36 million kw. from 30 million), while power production increased 32 per cent.

Construction and recovery was discussed from the material producer's viewpoint by I. N. Tate, St. Paul, vice-president of the Weyerhaeuser Sales Co. Mr. Tate declared that "the small-house field, privately financed, is the most fertile spot and promises the largest and quickest return from intelligent and intensive cultivation". He pointed to the fact that 75 per cent of our housebuilding has been done for that 25 per cent of the people who can afford a $5,000 house or better as demonstrating that housing has not been done very intelligently. On the possibility of preassembly he said that "complete standardization on modular scales and group erection seem now to carry promise of much greater savings than does complete fabrication", but declared that no one should delay building by present methods in the fear that his house will be outmoded by such construction practice, because changes of the kind are evolutionary and slow.

While Mr. Tate praised home ownership, he said that a housing program cannot be entirely a home-ownership program but must be carried in part on a rental basis. In the latter field he saw large investment possibilities.

The meeting as a whole was devoted to recovery problems, and included a large group of papers on existing deterrants to enterprise and the possibility of restoring industrial initiative, on difficulties caused by the Labor Relations Act, on the Public Contracts Act, on transportation problems, and others.

DIESEL TRUCKS OPERATE IN TUNNEL

Excavation in the tubes at the Manhattan end of the Queens Midtown Tunnel under the East River in New York City is being handled by diesel trucks operating in the tunnel. As soon as a blast is fired at the face, a diesel-powered shovel is brought up to the face and loads the shattered rock directly into the trucks.

The Manhattan tunnel consists of two tubes, 822 and 687 ft. long, respectively, running from the Manhattan plaza to connect with the main under-river tubes.

Woodcrest Construction Co. and Rosoff Bros., the contractors on the Manhattan end, had to obtain special permission from the New York state department of labor and the New York City Tunnel Authority, in order to operate internal combustion engines in the tunnel. This permission was granted because of the low carbon monoxide content of diesel exhaust; tests with the shovel running and trucks operating in the hole indicated a carbon monoxide concentration of 0.005, while 0.03 is the permissible maximum. Ventilation is provided by 15,000-cu.ft. capacity blowers.

Referring to the Public Contracts Act, President George H. Davis of the Chamber of Commerce cited a specific case as follows:

"The other day I was notified by my office in Kansas City that one of the young zealots of the Labor Department was trying to convince my firm that we should pay overtime for a week's work to the men in our 10-million-bushel grain elevator. The assumption was that because we sold over a period of six months several carloads of oats to a Texas firm, who later sold them to a Kansas army post, we were liable under the Walsh-Healey Act. We had no contracts with the U. S. government, and in fact up until the arrival of the Labor Department representative did not even know that the oats ultimately had become the motive power for an army mule. It would be much cheaper to pay the extra wages than the expenses involved in proving the Labor Department wrong, but the autocratic visit of the zealous young administrator to the men in our elevator creates the impression in their minds that we have not dealt fairly with them."

Resolutions included a declaration against pump-priming expenditures, proposal of specific amendments to the Labor Relations Act, and demand for the defeat of the Borah-O'Mahoney bill, which bill, it was declared, would authorize Congress to confer the right to engage in interstate commerce, "whereas it has always been understood that this right belongs to the citizens of the states and that Congress has a duty to protect it.

Old Tunnel Scorned On Penn. Turnpike

All three bidders on the Allegheny Tunnel of the new Pennsylvania Turnpike chose to drive a completely new tunnel rather than finish the tunnel which was started by the builders of the old South Penn R.R.

The railroad builders drove 3,929 ft. of the 5,926-ft. tunnel more than 50 years ago. Meanwhile, the roof has fallen in in many locations, and considerable work would be required for reinforcement to prevent cave-ins during construction.

The low bid was submitted by Guthrie-Marsch-Peterson Co. of Chicago at $2,672,000.

• • •

Two States Pass Housing Measures

The Missouri legislature late last month passed a bill permitting St. Louis to form a housing authority to borrow money from the U. S. Housing Authority for low cost housing projects.

A similar bill, but including provision for rural housing authorities, was passed by the Oklahoma legislature in the closing days of its session. Considerable doubt as to the validity of the measure arose, however, when it was discovered that the bill was not signed by the speaker of the House before the legislature adjourned; the Oklahoma constitution requires that bills be signed by the speaker in the presence of the House.

Corpus Christi Jobs Are Described

Texas Section of Am.Soc.C.E. holds spring meeting in Corpus Christi

Papers describing a number of important projects recently carried out or planned at Corpus Christi were an outstanding feature of the spring meeting there of the Texas section of the American Society of Civil Engineers, Apr. 28-29.

L. M. Adams, director of the Nueces County Navigation District, said that the 21 mile channel from the gulf to the port, which was originally 25 ft. deep and 200 ft. wide, has now been deepened to 30 ft. to accommodate larger vessels. The 1938 traffic—975 vessels carrying 7,000,000 tons—indicates that etxensions must be made in the near future. It is planned either to extend the canal about 4½ miles inland and build a new turning basin or to enlarge the present main turning basin.

E. N. Noyes, Dallas consulting engineer, described plans which are now under way for erection of a new seawall to protect the city of Corpus Christi to an elevation of 14 ft. above sea level. The project includes a two-mile seawall and a backwater levee. Rights of way have been acquired for the project and some contracts let.

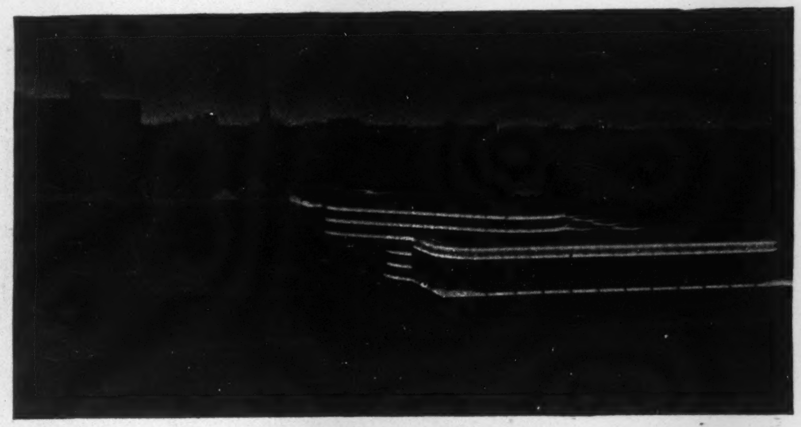
Noyes said that the seawall consists of a step-type concrete wall 14 ft. high. A row of steel sheetpiles 15 to 24 ft. long will be driven at the toe of the wall to solid material. The wall itself is supported by creosoted pine bearing piles about 12 ft. center to center.

At the business meeting, it was decided to appoint a committee to study the problem created by the fact that many of the junior members have been unable to accumulate sufficient experience to qualify them for the grade of associate member. It was suggested some change might be made in the upper age limit of the junior group.

• • •

Industrial Water System Exempt from State Code

The industrial water system being built for the Irvin Works of the Carnegie-Illinois Steel Corp. need not comply with the Pennsylvania state plumbers code, the Dauphin County (Pa.) court held May 4. In a case brought by the plumbers' and the steamfitters' unions of Pittsburgh, both claiming jurisdiction over a water line from the Monongahela River to the plant, the court held that the steamfitters could lay the line.



INDUSTRIAL SCENE—1939

ON THE FIRST of this month office forces of S. C. Johnson & Son, Inc., wax makers of Racine, Wis., moved into their new building, with which readers of *Engineering News-Record* are familiar through the article "Office Building Without Precedent" published in the Dec. 9, 1937 issue, p. 956. Unusual or novel are tame words to describe this latest product of Frank Lloyd Wright, exponent of functionalism.

The above scene, at dusk, shows the interior lighting coming through the wall bands and skylights of glass tubing. Expected construction time for the building was exceeded by a year and a half and costs by a wide margin, if the 80 to 90c. per cu. ft. figures reported are correct, but no other building can challenge its originality.

LABOR NOTES

Eleven construction projects in the Tri-City area (Davenport, Iowa, and Moline and Rock Island, Ill.) were slowed up last week by a strike of the common laborers union, which is seeking to increase the flat rate of 65c. an hour to a sliding scale ranging from 75c. to $1.25. The skilled crafts remained at work.

At nearby Waterloo, laborers also went on strike, seeking a 5c. raise to 65c. an hour. In this case demands were also presented by the cement finishers, who want $1.12½ an hour, and the truck drivers, who want union recognition.

At Mason City, plumbers walked out, demanding that their $1 an hour pay be increased to $1.21½.

A general strike embracing most of the building trades in Baltimore (*ENR*, Apr. 29, 1939, p. 7) was ended early this month when it was agreed to submit the matter to negotiation through the Building Trades Department of the AFL. The strike began when the Baltimore Building Trades Council ordered its members to refuse to handle material delivered by nonunion drivers. The AFL laborers, carpenters, bricklayers, and operating engineers, however, who are organized as the Baltimore Basic Building Trades Alliance, disregarded the strike order of the council. The resulting strike of the specialized crafts later merged into a dispute between the teamsters and truckers union and the operating engineers as to jurisdiction over transit-mixed concrete.

Also settled last week was a two day strike of carpenters on the Red Hook housing project in New York City (*ENR*, May 4, 1939, p. 7), called in an effort to obtain jurisdiction over placing of bases for brick and terra cotta walls. Through the intervention of the mayor, the dispute was submitted to the arbitration procedure of the Building Trades Employers Association of New York City.

Building laborers in East St. Louis, Ill., who went on strike Apr. 17 (*ENR*, Apr. 27, 1939, p. 47) seeking a wage increase from $1 to $1.25 per hour, returned to work Apr. 29 at the original pay scale, but reserved the right to demand the higher rate on jobs started after Apr. 29.

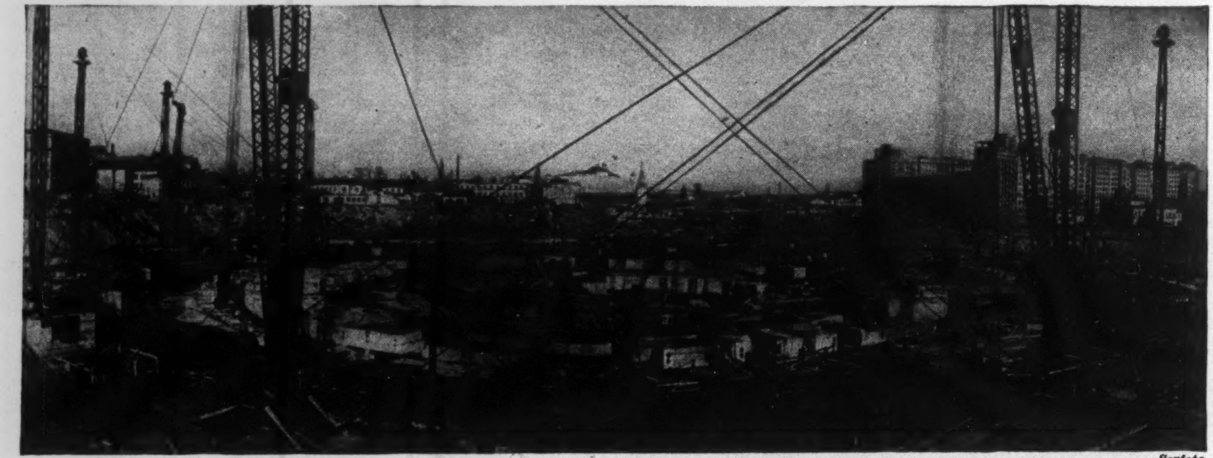
Wages fixed by the joint committee of the building trades of Montreal do not apply to the construction of sewerage systems, the Quebec court of appeals decided last week in rejecting a claim against a sewer contractor for failure to pay the fixed scale of wages. Under Quebec law, wages agreed on, under certain required procedure, by the trade associations and unions in an industry become the legal minimums in that industry.

• • •

Contractor and Engineer Sued on Dam Failure

Farm owners whose property was damaged in the flooding out of the partly completed Short Mountain Creek Dam near Paris, Ark. last month (*ENR*, Apr. 27, 1939, p. 43) have brought suit against the S. E. Evans Construction Co., contractor on the dam, and Hugh Carter of Little Rock, engineer in charge of the dam and waterworks project. The suits charge negligence and ask damages totaling about $14,000.

In a statement to *Engineering News-Record*, Carter said, "The suits filed have no merit, inasmuch as the dam was not up to grade nor the spillway down to grade. The dam did not fail and will not fail when completed, because the design of the spillway and the dam carries a factor of safety of four."



Sovfoto

FOUNDATION FOR WORLD'S TALLEST BUILDING NEARS COMPLETION

Under construction since the fall of 1935, foundation work on the Palace of Soviets at Moscow has now reached the point where grillages to support the steel columns of the great central circular shaft of the building have been set. The outer circles of columns, those for which the grillages have been set in the above view, are carried on two circular walls 3.8 meters thick, 22 meters high and 140 and 160 meters in diameter. The base of the inner wall is widened to 4½ meters. Deep beams on radial lines at the column points connect the two walls at their tops and carry a ring of smaller interior columns on short cantilevers.

The underlying material of the site consists of fill and glacial moraine 12 meters deep, 9 meters of broken limestone, 7 meters of marl and clay marl, a second layer of limestone and one of clay of about 7 or 8 meters each over a deep bed of limestone. The two outer rings of footings are carried down to the second bed of limestone. This was done in open cut, though the bottom is 20 meters below water level, by constructing a curtain wall of asphalt grout that shut off seepage through the clay and marls.

The Palace of Soviets will have a total height of 1,400 ft. and the maximum column load will be 23,600,000 lb. as compared with 10,340,000 in the Empire State Building at New York. The gross bearing on the second bed of limestone will be 40,000 lb. per sq. ft. The foundations were designed and the program of construction procedure was laid out by Moran, Proctor & Freeman, New York.

P.C.A. Receives Award For Soil-Cement Roads

The 1939 award of the American Trade Association Executives has been given to the Portland Cement Association for its work in developing the soil-cement road. The award is made every year to a trade association judged to have rendered outstanding service to its industry, to industry in general, and to the public.

Under the direction of Frank T. Sheets, president, the Portland Cement Association has developed laboratory and field methods for processing native soil, water, and portland cement, to produce a weather-resisting highway for light traffic. Analyses have been made of the local soils from 44 states as well as the District of Columbia and Alaska. Direct charge of field and laboratory work has been in the hands of M. D. Catton.

Soil-cement roads are constructed by scarifying the highway, adding cement and dry mixing, and adding a definite amount of water. The roadway is compacted with sheepsfoot rollers, the surface smooth-rolled, and the road allowed to cure.

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Ontario Denies Liability For Off-Road Accidents

The provincial legislature of Ontario has passed an act barring actions against the department of highways for damages resulting from accidents occurring off the traveled section of any provincial roadway. The new limitation on the liability of the highway department was adopted as the result of a recent decision in which damages were awarded to the driver of a car which struck a guard rail at the side of a highway, went through, and fell into a ravine.

The provincial minister of highways said that neither the department nor any municipality should be required to erect guard rails of sufficient strength to withstand the impact of an automobile.

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Road Bids Thrown Out To Spike Rumors

Because rumors had been circulating that contractors dealing with certain bonding companies would receive preferential treatment, highway commissioner Phillips of Tennessee, late last month threw out, but later re-accepted, 54 bids on six construction projects with a total cost of about $550,000.

In a telegram sent to all bidders the day before bids were to be opened, Phillips said that "no possible advantage can be had over your competitors in bidding through the employment of any individual or particular firm, either in the making of bonds or purchase of materials."

A week later, the commissioner said that the Bureau of Public Roads did not regard the matter of bid bonds as sufficient grounds for rejection of the bids and said he would make the award on the basis of the original bids. He did, however, cancel his personal bond of $125,000, which he said had formed the basis of the rumor, and distributed it among five companies.

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Oklahoma Restricts Road Building Work

In order to pay off a $4,700,000 deficit outstanding at the beginning of the year, the Oklahoma legislature has decided to stop all highway construction except federal aid work and necessary maintenance. By this means it will be possible to pay off the deficit in less than two years without funding the debt. The legislature has also set up a budget system providing closer regulation of highway department expenditures.

The department expects soon to let $2,200,000 in contracts on federal aid projects.

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Big Turbines Bought For Shasta Dam

Contract to furnish four 103,000-hp. turbines, together with their governors, to be installed in the power plant at Shasta Dam of the Central Valley reclamation project in California, was awarded May 4 to the Allis-Chalmers Mfg. Co. of Milwaukee on its bid of $1,843,000. These turbines which are smaller than the 115,000-hp. units at Boulder Dam and the 150,000-hp. units which will be used at Grand Coulee, comprise the initial installation at Shasta. The ultimate installation will include another unit of the same size.

Contract has also been awarded to James Leffel & Co. of Springfield, Ohio, covering two 3,500-hp. turbines, with governors, for station service.

The big turbines will be of the vertical-shaft single-runner Francis type with spiral casing. They are designed to operate at a normal speed of 138.5 r.p.m. at a head varying from 283 to 475 ft.; average effective head will be about 408 ft.

Under the contract, the draft tube lining for the first turbine will be completed in 630 days, and the fourth unit must be completed in 1,110 days. Station service units must be delivered in 800 days.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

Reorganization of federal agencies will go into effect June 25 unless the House rescinds its approval or Congress adjourns before then.

Since the President's reorganization plan setting up a federal works agency covered most of the provisions in the bill introduced by Sen. Byrnes, his measure was withdrawn. He is now engaged in preparing a new bill to carry his formula for federal and local participation in the cost of relief.

Transfer of the Bureau of Public Roads from the Department of Agriculture to the new federal works agency involves no change in the highway act. The bureau benefits in that it is now given a legal existence. Heretofore the bureau had no statutory status; it was an agency created by the Secretary of Agriculture to carry out authority vested in him. The head of the bureau under the new setup will be known as the Commissioner of Public Roads.

The last pour of concrete on Bartlett Dam was made April 28. It is not expected that the dam will be accepted from the contractor until mid-summer as the usual cleaning up work still has to be done. It has been decided to have the contractor undertake certain parts of the installation work.

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Highway Wage Law Overruled in Ohio

A 1938 law providing a minimum wage of $100 per month for employees of the maintenance division of the Ohio state highway department was held unconstitutional on a technicality by the Ohio Supreme Court May 5.

The law was passed by the general assembly of the state at a special session, and the court pointed out that a special session may pass only on matters mentioned in the governor's message calling the session; the minimum wage law had not been included in the governor's message.

Nullification of the act, according to state highway director Robert S. Beightler, will affect more than 5,200 employees. They will now be returned to an hourly basis of pay instead of receiving $100 per month for a 40-hr. week. The decision will result in a reduction of about $1,500,000 in the state's maintenance expenditures.

OBITUARY

Edward E. Perrault, former city engineer of Ottawa, died there Apr. 26 at the age of 81.

Charles F. W. Kunsemueller, treasurer of the St. Louis civil engineering firm of Myers, Keller & Byers, died Apr. 30 at the age of 66. Kunsemueller had been a member of the firm for the past fifteen years and earlier had been secretary to the St. Louis Board of Public Service.

A. Franklin Giese, on the staff of the engineer department of the Kentucky state department of welfare, died in Louisville May 4 at the age of 69. A graduate of Harvard, Giese was active for many years on railroad bridge construction in the West and had recently been construction engineer on the municipal auditorium and the municipal bridge at Louisville.

• • •

USHA Completes Loans To Seventeen Cities

The U. S. Housing Authority on May 4 completed loan contracts with seventeen cities under which the agency will loan $31,822,000 to meet 90 per cent of the cost of 28 low-rent housing projects. These contracts bring to $409,698,000 the total of outstanding USHA loan contracts. In addition, USHA has earmarked $246,941,000 for specific cities, making total commitments of $656,639,000.

The new contracts, providing for about 7,714 family dwelling units, bring to 85,416 the number of family dwellings in the current USHA program.

Largest of the new loans, $11,521,000, is to Boston, while Denver receives $3,132,000; Jacksonville, $2,510,000; Charlotte, N. C., $2,014,000. The smallest loan yet made, $183,000, goes to Sarasota, Fla.

• • •

Indiana Road Staff Cut In Economy Move

Reduction in the budget of the Indiana highway commission from $5,970,000 in 1938 to $4,903,000 for each of the next two years has made it necessary to drop about 200 employees in the highway department from the payroll.

The largest single cut was the abolition of the entire traffic and planning department, eliminating 129 workers most of whom are engineers. The cut reduces the department payroll by about $400,000.

John C. Riedel Honored For Long Civic Service

John C. Riedel, recently appointed to the principal administrative engineering position in New York City, that of chief engineer of the board of estimate and ex-officio commissioner of city planning, was honored by over 600 fellow engineers and city officials at a dinner held at the Commodore Hotel, New York, May 8.

Speakers were Raymond V. Ingersoll, president of the borough of Brooklyn, under whom Riedel served for a number of years, Gano Dunn, president of the J. G. White Engineering Corp. and president of Cooper Union where Riedel taught for 35 years, and David B. Steinman, past president of the National Society of Professional Engineers. Arthur V. Sheridan, commissioner of city planning, acted as toastmaster.

The Steinman, representing the several organizations that arranged the dinner, presented Riedel with a watch and chain. To this Sheridan added a charm sent by Linford S. Stiles.

Riedel's service with the city began in 1901 in the bureau of sewers in Brooklyn, where he worked in the day time, teaching at Cooper Union in the evening. He was appointed to his present position in March.

NEW SAN FRANCISCO AIR BASE IS ON FILLED GROUND

Placing of 5,000,000 cu.yd. of dredged fill for the naval air base under construction in San Francisco Bay began early last year and is scheduled for completion the end of this month. It is expected that work will start soon on adding 8,500,000 cu.yd. to fill in the area indicated by the dotted lines above. Erection of buildings on completed portions of the fill began last month.

Dredging work now approaching completion includes excavation of a 1,300 x 3,000 ft. lagoon 12 ft. deep and a trapezoidal turning basin 1,000 ft. wide and 30 ft. deep. Additional yardage needed was taken from an access channel 30 ft. deep, 275 ft. wide, and 8,500 ft. long. The dredge in the foreground is working on the access channel.

Dredging contractor on this work is the San Francisco Bridge Co., while Commander E. C. Seibert, Civil Engineer Corps, U. S. Navy, is in charge.

CONTRACTS AND CAPITAL

Engineering construction awards for the week, $52,390,000, are 28 per cent below last week, and 24 per cent below the volume for the corresponding 1938 week. This is the first time in the past 9 weeks that construction awards are lower than their respective values in 1938.

Construction volume for the year to date, $1,167,494,000, is 22.5 per cent higher than the $953,401,000 total for the 19-week period last year.

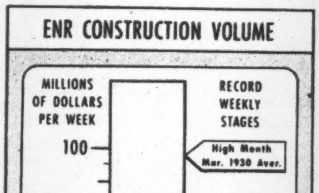
Private awards for the week are 23 per cent above the preceding week, but are 10 per cent under the 1938 week. Public construction is 38 and 28 per cent lower, respectively, than a week ago and a year ago.

In the classified construction groups, industrial building volume reached the third highest week of the year as a result of 3 large projects in Massachusetts, Alabama and Washington totalling almost $7,000,000. In addition to industrial buildings, earthwork and drainage reports an increase over last week; and sewerage, public buildings, earthwork and drainage, and unclassified construction are above their respective totals for the 1938 week.

New capital for construction purposes totals $105,748,000 for the week, the second highest of the year, and 664 per cent above the $13,829,000 reported a year ago. The current week's financing is made up of $41,804,000 in state and municipal bonds, $31,822,000 in USHA loans, $28,699,000 in corporate security issues, and $3,423,000 in REA loans.

New construction financing for the 19 weeks of 1939, $795,330,000, is 47 per cent higher than the $539,856,000 reported for the corresponding period last year.

ENR CONSTRUCTION VOLUME



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WPA Is Approved

(Continued from p. 43)

the communities reporting, while only 75 per cent held that the quality of the administration was good. Eighty per cent held that the work had maintained the skill and employability of the workers.

The only point on which general disapproval was expressed was on the question whether the program had entirely covered the field of needy employable people. Fifty-one per cent of the reporting communities held that it had not.

Other specific criticisms of some features of the WPA program were voiced by the local communities. It was held that because unemployment had not been recognized as a long time program there has frequently not been the comprehensive planning which is needed. In many instances, sufficient discretion was not allowed to local officials, and there has not been enough flexibility to permit adjusting wages and hours to meet variations in local conditions. Local supervision of relief workers has been ineffective in many cases, and there has frequently been a lack of enough skilled workers on relief to permit full employment of unskilled workers.

It was pointed out that many small communities lack the technical ability to meet WPA requirements, which results in holding up projects. It is frequently found that there is more unemployment in winter and that it is difficult to find projects which can be carried out in cold weather. Workers were said to be afraid to leave WPA jobs for temporary work for fear they will not get back on the WPA.

Only two of the states, Iowa and Kansas, expressed themselves as in favor of state administration of the program. Twenty approved the present plan, and twenty expressed no opinion.

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Chicago Office Opened By Ulen & Co.

Ulen & Co., New York engineers and contractors, have opened a Chicago office to serve the Middle West. Vern E. Alden, vice president of the company, will be in charge of the office; Alden was formerly with Stone & Webster Engineering Corp.

Ulen's foreign operations will be confined to the New York office, and the entire attention of the Chicago office will be devoted to heavy construction and engineering in the domestic field.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN APRIL, 1939

Engineering News-Record *reports projects of the following minimum costs; — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

							United States			
								Four Months		
Public Works	**New England**	**Middle Atlantic**	**South**	**Mid-West**	**West of Mississippi**	**Far West**	**April 1939**	**1939**	**1938**	**Canada**
Waterworks	1,860	12,576	531	1,069	1,224	358	**17,618**	97,451	15,455	296
Sewerage	688	2,001	1,196	5,521	2,002	968	**12,376**	67,385	35,152	43
Bridges, public	787	1,751	1,385	4,572	3,102	472	**12,069**	58,722	26,423	73
Earthworks and waterways	427	800	5,644	1,547	979	1,904	**11,301**	53,862	84,741	235
Streets and roads	1,828	15,743	7,291	26,896	15,504	4,555	**71,817**	212,962	137,757	718
Buildings, public	813	18,142	10,452	5,844	7,523	2,922	**45,696**	226,725	131,261	195
Unclassified, public	278	3,942	3,324	709	2,642	1,517	**12,412**	58,571	35,924	1,581
Total public	**6,681**	**54,955**	**29,823**	**46,158**	**32,976**	**12,696**	**183,289**	**775,678**	**466,713**	**3,141**
Federal government (included in above classifications)	666	2,745	2,272	1,810	1,706	3,755	**12,954**	74,375	88,938	....
Private										
Bridges, private	....	....	....	....	....	....	....	2,065	2,486	....
Buildings, industrial	683	1,815	1,120	1,373	983	1,179	**7,153**	54,492	64,732	1,723
Buildings, commercial	4,797	24,483	1,758	2,898	2,804	2,794	**39,534**	139,542	275,294	726
Unclassified, private	275	831	1,137	3,893	3,910	713	**10,759**	70,060	38,834	76
Total private	**5,755**	**27,129**	**4,015**	**8,164**	**7,697**	**4,686**	**57,446**	**266,159**	**381,346**	**2,525**
Total Engineering Construction:										
April, 1939 (4 weeks)	**12,436**	**82,084**	**33,838**	**54,322**	**40,673**	**17,382**	**240,735**	....	....	**5,666**
March, 1939 (5 weeks)	19,812	109,429	38,294	45,020	49,722	23,289	**285,566**	....	....	7,344
April, 1938 (4 weeks)	11,406	94,478	14,815	20,132	37,734	14,809	**193,374**	....	....	9,069
Four Months — 1939	64,336	345,386	148,147	191,139	195,025	97,804	....	1,041,837	....	21,920
Four Months — 1938	34,641	388,156	79,557	97,472	140,247	107,986	....	....	848,050	23,243

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Cement Technology

Sir: After some six years of intensive reading of matters relating to cement technology, I have reached the following conclusions, which may interest those of your readers who follow these matters:

1. That the absence of a percentage designation for lime is notable in the standard accepted specification.
2. That the same applies to silica.
3. That the specification for insoluble residue at 0.85 per cent to indicate the completeness of burning is a fallacy. It is an indication of the completeness of the acid base reaction and is in no way associated with the durable quality of a cement except perhaps in reverse.
4. That loss by ignition is the proper indicator of completeness of burning or calcination.
5. That no two cements are alike in performance under certain conditions, and that a study of water retention or bleeding may go a long way toward solving this problem.
6. That unless the engineer becomes more chemically minded in his application of cement and concrete to his problems, little if any progress will be made.

Chas. L. Kirk
Vice President
Eddystone Portland Puzzolan Cement Co.
New York, April 13, 1939

Stresses in Tall Risers

Sir: Not long ago, it was my duty to check the design of a tall riser subject to heavy vertical loads in addition to the hydrostatic head.

I found that the designers had endeavored to determine the stresses according to a theory developed through laboratory tests of cylindrical shells loaded as columns only, without any hydrostatic pressures; and, that beyond allowing for ring forces in the shell, they had disregarded the effect of the hydrostatic load.

The hydrostatic load will cause a bulge in the walls. This means, of course, that there will also be bending moments, shear forces, etc., set up in the walls. This bulge will, however, act as a lever arm for the vertical loads, with a new set of moments and forces to be added. This will in turn further enlarge the bulge and so on till equilibrium has been reached. By that time the stress picture may be radically different from that arrived at by the method as mentioned above.

In our case the designers claimed a maximum stress of 7,600 lb. per sq. in., while the actual stresses would have exceeded the elastic limit of the material, if they had been permitted to have their own way.

As the stresses increase at an increasingly steep rate with increasing radii, I believe that to design risers by divination is quite a dangerous pastime.

I. S. Rasmussen
Hillsdale, N. J., Feb. 10, 1939

Fort Peck Dam

Sir: The matter of the reconstruction of the Fort Peck Dam is now brought up sharply by the release of the report of the board of able engineers appointed following the collapse of last September.

The suggestion is here made that a qualified board of practical economists be appointed to thoroughly consider the question whether the great cost of the dam is justified by whatever its benefits may be. Prof. Warren J. Mead is too able an engineer to have any recommendation of his ignored. Many of us agree with him.

I am not in the least questioning the judgment in the technical engineering matter passed upon by the recent board of engineers. What I wish to emphasize is the economic aspect of the whole proposition.

Of the three major projects in the course of construction, Fort Peck, Grand Coulee and Bonneville, not one in my opinion can be justified as necessary at the present, or for many years to come, as an economic necessity, and I believe that a board of practical economists would agree with me. And now at Fort Peck when there is a distinct prospect of having to spend more money than was estimated, I think it is a good time to halt the whole foolish proceedings."

John F. Stevens
Southern Pines, N. C.

Joseph Andrews Sargent: An Appreciation

Sir: American engineering reputation rests largely on the achievements of the pioneers of the profession—the men who built railroads and canals, controlled rivers, brought water to the deserts, and made possible prosperous communities in otherwise inaccessible and inhospitable regions. They had the vision to foresee, the intelligence to plan, the ability to execute, and the courage to shoulder responsibility for the outcome.

These were the "rugged individualists," now in disrepute, who built up in the wilderness and the desert a civilization and a society to be used as playthings by the mushroom economists and hot-house theorists of a later generation.

Joseph A. Sargent, whose death was noted in your issue of April 27, p. 540, was one of that small and rapidly vanishing group. A lineal descendant from the band of intrepid colonists who, more than three centuries ago, undertook to build homes on a newly discovered continent, the pioneer spirit was an integral part of his character. His father was one of the early railroad builders of the West. The son, following the father's footsteps, engaged first in railroad location and construction, later in the irrigation development of the semiarid West. As assistant to Sir William Van Horne on the Cuba railways, and in after years as a valued adviser of the late F. S. Pearson, in Spain, and of the late I. W. McConnell, in Brazil, Mr. Sargent amply demonstrated those qualities which distinguish the real engineer from the pedantic pretender, and more than justified the great trust which had been placed in his judgment.

A few years ago a distinguished engineer of international reputation said in my hearing: "Joe Sargent is the only man I know whose judgment on a field problem I would rather have than my own." In these days when the engineer has degenerated to a mere technician entirely surrounded by reference books and academic degrees, when everything is standardized, individual thinking is at a discount, and "good practice" is determined by majority vote, no higher compliment could be paid to engineering skill.

A chronological record of any man's life is, at best, a drab recital which does not reflect the salient features of his character, but his attitude toward others is significant.

Sargent was loved and admired by all who knew him—the financiers who managed their funds under his advice, the educated and cultured men of his own class, and the poorest laborers who worked under his direction. He was a loyal and generous friend; he had no time to waste in being an enemy to anybody. In many years of association with him I never heard him say an unkind word about anyone. He talked much of his former associates—invariably to extol their virtues and to speak admiringly, almost extravagantly, of their superior skill and attainments. When he spoke of his own experiences it was only to build a background against which the work of his colleagues might stand out more clearly. He was always courteous, but he never kotowed to those who happened to rank him at the time, nor did he ever bully a subordinate. A valuable suggestion might emanate from any source, high or low; he did not hesitate to utilize it nor to give full credit and recognition to its originator. He was never less than fair in his dealings with others; his cards were face up on the table at all times.

Perhaps the one trait which stood out in the strongest relief was his absolute intellectual honesty. There was neither pose nor pretense of learning in any of his discussions. No matter how elementary the question, if he did not know the answer he said so in unmistakable terms. A necessary consequence of this mental attitude was scrupulous financial honesty; he took no fees or salary under false pretenses.

It is a platitude that the place vacated by any man is readily filled by another, but it is not always true. Sargent's place in the world may be *occupied*, but it will not be easily *filled*. Those who are so concerned about raising the standard of the engineering profession would do well to take a few leaves from his book.

Charles W. Comstock
Consulting Engineer
New York, N. Y.

May 8, 1939.

Detour Signs

Sir: On page 72 of your issue of Jan. 19, 1939, is an article crediting the Pennsylvania Highway Department with the development and use of an improved detour sign which, by implication, is unique.

If the New York State Highway Department does not rise to this it should. In the latter part of August, 1925, in the village of Pulaski or some small place near it, I encountered a detour sign identical in principle and general design with the one you picture. I have often wondered why this type is not in more general use.

C. P. Fiske
Palmerton, Pa.

Survey Field Tables

Sir: In an article entitled Abney Level in Road Surveys by Stuart D. Long (*ENR* April 13, 1939, p. 495), Mr. Long concluded his interesting article with this statement: "Tables are for sale by the Superintendent of Documents, Washington, D. C." What I would like to know is the official title of these tables and their cost.

Jack E. Hollis
Montebello, Calif.

Sir: The tables referred to in my article on the Abney Level method of grade location were compiled by the United States Department of Agriculture, Forest Service, and are titled "Engineering Field Tables." The price is 75c, bound in cloth, from the Superintendent of Documents, Washington, D. C.

The contents are: curves, surveying, meridian observations, trigonometric functions, earthwork (used in the article), road surfacing, pipe culverts, concrete, timber, miscellaneous.

I might add that this publication, as are so many government publications, is well worth the price.

Stuart D. Long
East Grand Rapids, Mich.

Errors in Unit Prices

Sir: May I call your attention to errors in your unit price data for Pinopolis lock, dam and power plant published in *Engineering News-Record*, April 20, page 534? The description reads in part "in addition to cement, owner will supply . . ." While the South Carolina Public Service Authority took bids on cement with which to secure an optional price available to the contractor, the cement will be purchased by the contractor and the cost thereof is included in the unit prices bid for items 21 to 28 inclusive.

In both schedules 1 and 2 the column headings do not correspond with the proper bidders. Actually, Column 1 is the engineer's estimate. Column 2 in Schedule 1 is the low bid of Central Engineering Co., and Column 3 is the second-low bid of Bates & Rogers. In Schedule 2, Column 2 is the low bid of W. C. Shepherd, and Column 3 is the second-low bid of United Construction Co.

H. G. Gerdes
Harza Engineering Company
Charleston, S. C.

[To correct for these errors in using the unit prices as published the identifying number in the first column should be changed so that (1) is the engineer's estimate. Then the low bidder will be (2) and the second-low, (3). —Editors.]

Another Reader "Going On 50 Years"

Sir: In going through my diary I came across the following:

August 7, 1890—10:30 A.M. perched on a stool in the water department of the city engineer's office, Providence, R. I., and was put to work adding up figures in tabulation of Weston's "Flow of Water in Small Pipes."

Edmund B. Weston, member Am. Soc. C. E., was in charge of the water department. J. Herbert Shedd was city engineer. My salary was $15 per month.

I read *Engineering News* and *Engineering Record* during the lunch hour.

F. H. Shaw
Lancaster, Pa.

It Is in Ohio

Sharp-eyed readers read the words "Ohio Department of Highways" on the building picture on p. 553 of the April 27 issue which had a caption indicating that it is in Pennsylvania. Needless to say, the building is in Ohio. A change of pictures was made in adjusting the article to available space, but the captions were not changed when the shift was made—

Editor

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Editorial Offices at 330 West 42nd Street, New York

MAY 11, 1939

ANCIENT TRADITION has it that when engineers meet in technical discussion partisanship is forgotten, in the professional spirit that often brings opposing attorneys together in amicable luncheon conversation. It is regrettable that this tradition was not strong enough to assure Arthur E. Morgan's participation in the program of the meeting of the American Society of Civil Engineers held in Chattanooga late in April. Without him a discussion of the engineering phases of the great enterprise could hardly be complete, for his statement of the motivating thought of the river-control plan which he developed would have been of great inspirational value. There is no good reason for allowing the shadow of past discord in the TVA directorate to fall across the pages of our engineering annals.

Watch Your Blasting Caps

APPROACH OF VACATION TIME brings the warning of blasting-cap accidents to children. Once again the Institute of Makers of Explosives issues its annual appeal to users of explosives to reduce the tragic toll of children maimed, blinded or killed by innocent playing with loose caps. Every such accident is the result of wanton carelessness on the part of some adult. The shiny caps so fascinating to children cannot fall into their hands if the exploders are properly kept. Caps left lying around the job, stored in easily opened toolboxes or carried loose in pockets are a source of childhood danger. Surely, to the users of explosives the saving of a youngster's eye, hand or fingers, or even its life, is important enough to warrant extra care in keeping detonating caps out of reach.

Freezing Soft Ground

SOLIDIFICATION of soft ground by freezing has been little used in this country in recent times. Yet in the rare instances where the process has been tried it has proved successful. Three recent ground-freezing cases come to mind: the slide at Grand Coulee Dam, the calyx drill explorations at the Fort Peck slide, and the exploratory shaft at Gilbertsville Dam, reported in this issue. The success of these operations raises the question why ground freezing is not in wider use. High cost may be a deterrent, though any method of handling ground adapted to freezing is expensive. Probably lack of knowledge and experience on the part of engineers and contractors is the main reason. In this light the statement that "ways of improving the freezing method became apparent during and after the experiment" in the current Gilbertsville article is significant. Is freezing being overlooked and neglected as an aid in handling bad ground because the method has not been given sufficient study and trial in modern construction practice? Here is a challenge to progressive engineers and contractors.

Express Roads

THE REPORT of the Bureau of Public Roads on a plan of express road improvement ranks as one of the most important guide documents of public policy in developing modern road transport since the federal-aid laws of 1921. As presented this week, even in the necessary brevity of an abstract the report carries too much of future significance to highway transport to excuse brief discussion, and more deliberate consideration is reserved for another time. The important fact to be kept in mind for the moment, however, is that in no sense is the decision against express highway construction. On the contrary, it advocates a system of express roads far more comprehensive than that which Congress laid down for specific consideration. Its great contribution is bringing measured fact to bear on the problem and relegating to well-deserved limbo the fantastic schemes for transcontinental superhighway grids that often find voice in Congress.

First-Class City Engineering

FEW OCCUPATIONS offer as great a challenge to versatility in leadership as well as in technical skill as does city engineering. Regardless of the size of a municipality, the operation of public works services calls for administrative ability of a high order and a wide range of engineering knowledge. The story in this issue of activities at St. Petersburg, Fla., is an illustration in point. Worthy of special note is the organization of the city's department of public works where activities have been thoughtfully defined for efficient conduct of business and effective utilization of personnel; in particular should be noted the inclusion of a bureau of federal projects, so-called, to expedite and coordinate the ever-increasing federal-city relationships. Good organization is properly recognized here as one of the most important elements of successful administration. Attention is also directed to technical accomplishments, which go far beyond the scope of routine city engineering. What is being done in St. Petersburg, as well as in other progressive municipalities, should be an inspiration to those who seek career opportunities in public service engineering.

Bridge Fires

"THERE ARE TOO MANY FIRES in bridge floor systems", said a well-known bridge engineer recently. Causes were varied, in the examples he cited to prove his point, but results were alike in inconvenience to the traveling public and added expense for bridge maintenance and repairs. Laminated timber decks have been used extensively under asphaltic surfacing. Although this construction now saves relatively little over the cost of a concrete floor system, the additional weight of the latter in some cases increased the cost of the bridge structure, but the Bureau of Public Roads requires that steel bridges with laminated timber decks must be designed to carry a concrete deck, which may become necessary later. Such cost additions as well as the cost of maintenance and the fire risk enter into comparative studies of bridge deck types.

Put Them to Use

THE NEWS that one state, Georgia, has completed its statewide system of control surveys makes it timely to recall that in this survey work the WPA in cooperation with the Coast and Geodetic Survey and active engineering groups is creating an asset whose potential value is hard to overestimate. The network of control lines established by these surveys defines the exact position of land monuments and benchmarks set close enough to enable any surveyor to tie into the network. For the first time in history, surveyors and landowners are enabled to define and record their land boundaries in terms permitting them to be retraced beyond dispute even when all local marks and corners are lost. But in order to make this possibility real, the control points and surveys must be put to actual use. This means that the system requires to be publicized and popularized among public and corporation officials as well as among engineers, so that all may know of it and understand how they can put it to profitable use.

More Light Needed

HYDRAULIC-FILL dam construction had one of the worst experiences in its history last September in the great slide at Fort Peck. Engineers who may have to build such dams in future will need full guidance on what was discovered and learned in that accident, so that they may build more safely. The investigating board, in its report published in this issue, fails to give such guidance.

Adequate for the immediate purpose of showing what steps should be taken at Fort Peck, the report gives little or no information about the problems of earth dams and especially those of hydraulic-fill dams in general. There have been other slides of such dams during construction, and some engineers believe that special hazard attends the building of the upper, narrow part of a structure by hydraulic means. Whether and to what extent the Fort Peck occurrence confirms the existence of such a hazard is a matter of first concern.

Two or three years ago it was discovered that a loosely deposited mass of sand if later saturated might undergo sudden liquefaction when disturbed by a shock or otherwise, and the Fort Peck slide was believed by many to be due to such liquefaction. It was therefore to be expected that the report would place the question beyond doubt. The two sentences which the board devotes to the question of cause are quite insufficient for this purpose.

One noteworthy fact of the case was that the dam had been built up unusually fast during the several months just preceding the accident. It was suspected by some that the high speed of construction, perhaps coupled with the lowering of the reservoir during the same period, contributed to the slide. The engineers in charge of the work no less than other engineers interested in dam construction were entitled to a declaration by the inquiry board on this possibility, but again the report is silent and Mr. Merriman's separate statement does not bear on this important point.

Since these and many other questions remain, now that the immediate purpose of inquiry has been served and reconstruction is under way the interests of engineering knowledge justify further study and a more detailed report that will examine all circumstances and questions surrounding the subject. The Fort Peck experience offers an opportunity to make a significant contribution to the art of safe dam construction. All available data should be placed before a board of experienced builders of hydraulic-fill dams with the request that the board make definite findings on the larger questions that remain unanswered.

Public Works and Relief

REORGANIZATION of federal departments under the President's Order No. 1 contains good and bad news. The good news is that the first beginning of the public-works department which engineers have long advocated is provided through the establishment of a single agency to take over a number of construction functions now scattered among different bureaus. The bad news is that relief work has been grouped with public works in the same agency. The risk of infecting public-works planning and construction with the relief atmosphere and habits, or worse still the risk of exploiting public works as a field in which relief may run riot, is too serious to be tolerable.

Public works and relief will not mix. They are diametric opposites in purpose and method. Efficiency governs one and inefficiency follows the other. Public works seeks to produce the largest amount of structure for the least number of dollars by utilizing the skill and experience of the construction industry and of the best craftsmen; work relief scorns these aids and objectives in order to provide work for some by taking it away from others.

The combination of relief and public works decreed by the President's order is fundamentally unsound. But if it becomes effective, as well it may, the best must be made of a bad situation. The solution lies in wise and far-seeing administration which will recognize the incompatibility of the two functions and provide for keeping them as completely separated as if they were independent.

In fact, a public-works administrator who recognizes this incompatibility could eliminate some of the worst abuses of the system. He could inject soundness, efficiency and discipline into WPA operations. He could limit the scope of WPA and could work toward its speedy termination, as the indispensable prerequisite of real recovery.

The responsibility resting on the public works administrator to avert harmful results from the combination of public works and relief will be a heavy one, and one that can be discharged only with the full support of governmental policy.

Discordant Figures

SO MUCH has been said for and against the Florida Canal that the project has become a matter of emotional rather than factual judgments. Opinion is either strongly for it or as strongly against it; one side holds that it is a beneficent undertaking, a large contribution to employment, and an aid to transportation economy, while the other considers it uneconomic, not useful to traffic, valueless in relief of unemployment, and tainted with suspicions of political pork. This is unfortunate, for the issue is entirely too big to be prejudged. Now that Congress is again giving consideration to the canal the engineering questions involved should have impartial examination.

There is the more reason for such a review because of the unusual record of past investigations and reports and the wide discrepancies between them. The Corps of Engineers has made many studies of the project, with final judgment adverse in each instance until the Chief of Engineers overruled the findings of the Board of Engineers for Rivers and Harbors two years ago. By cutting down the dimensions of the canal and reducing the cost estimates of the Rivers and Harbors board about one-fourth, and by excluding amortization, he found an income balance and recommended the project as advantageous. Thus a wide discrepancy in costs and economic calculations casts a cloud on the project.

The cloud is further deepened by a critical restudy carried out by the Association of American Railroads, just made public. The costs now found are much larger even than those of the Board of Rivers and Harbors, and nearly twice as large as the total cost reported by the Chief of Engineers—$354,000,000 against $197,000,000. Different methods of computation alone cannot account for this wide variation.

Plainly, if the project shows a slight net return on a cost below 200 million dollars, it is an uneconomic venture at a cost of nearly 400 millions. Incidentally, as both calculations depend on the large-scale use of excavating machines the unemployment-relief argument disappears and the issue becomes a plain one of cost and returns and of transportation utility. There need be no emotionalism or partisanship in considering this issue.

The differences of cost in controversy are so large as to constitute an engineering sensation. They warrant thorough exploration by Congress before the canal can be considered worthy of further consideration.

Large Slide in Fort Peck Dam Caused by Foundation Failure

***Summary**—The technical inquiry board that investigated the Fort Peck Dam slide of Sept. 22, 1938, reports that weakness of the shale strata underlying the valley fill caused the failure, and recommends reconstruction with flatter upstream slope. The new part of the core, built of rolled fill, is to be bonded to the old hydraulic fill core by steel sheeting. One member of the board favors more extensive reconstruction.*

Reporting on the great slide of Sept. 22, 1938, in the upstream bank of Fort Peck Dam, an inquiry board of engineers and geologists attributes the accident to shearing failure of the shale which underlies the valley fill on which the dam rests. As briefly noted in our news pages of April 27, p. 44, the board recommends rebuilding the destroyed section with flatter upstream slope and adding a wider and higher berm on the upstream side of the standing part.

The report, dated March 2 but released only recently, is signed by seven of the nine members of the board; it is abstracted below, together with a separate report by Thaddeus Merriman. The latter agrees with the general finding of cause but emphasizes the part played by hydrostatic uplift and calls for removal of more material from slide and abutment.

Prof. W. J. Mead, ninth member of the board, did not join in the report, though expressing agreement with the views of both the main report and Mr. Merriman in a letter. He holds that the usefulness of the dam is too small to warrant incurring the risk of failure that any engineering structure involves.

Our abstract is preceded by a description of the advance warnings that preceded the slide, and of the slide itself, from data furnished from official records by Maj. Clark Kittrell, U. S. District Engineer in charge of the project.

Settlement preceded the slide

Fort Peck Dam is an earth embankment 220 ft. high by 9,000 ft. long, with slopes of about 4 to 1 upstream and 8 to 1 downstream, across the valley of the Missouri River at the former site of Fort Peck, 20 mi. southeast of Glasgow, in northeastern Montana. It will form a reservoir of 19,500,000 acre-ft. capacity for improvement of navigation from Sioux City to the mouth by increasing the low-water flow, for flood protection, for irrigation and for generation of power. (For fuller data on the project see *ENR*, Aug. 29, 1935, p. 279.) When the slide occurred the dam proper was nearing completion, having been under construction since 1933 by force account under the Engineer Corps of the Army, with Col. T. B. Larkin and later Maj. Clark Kittrell in charge.

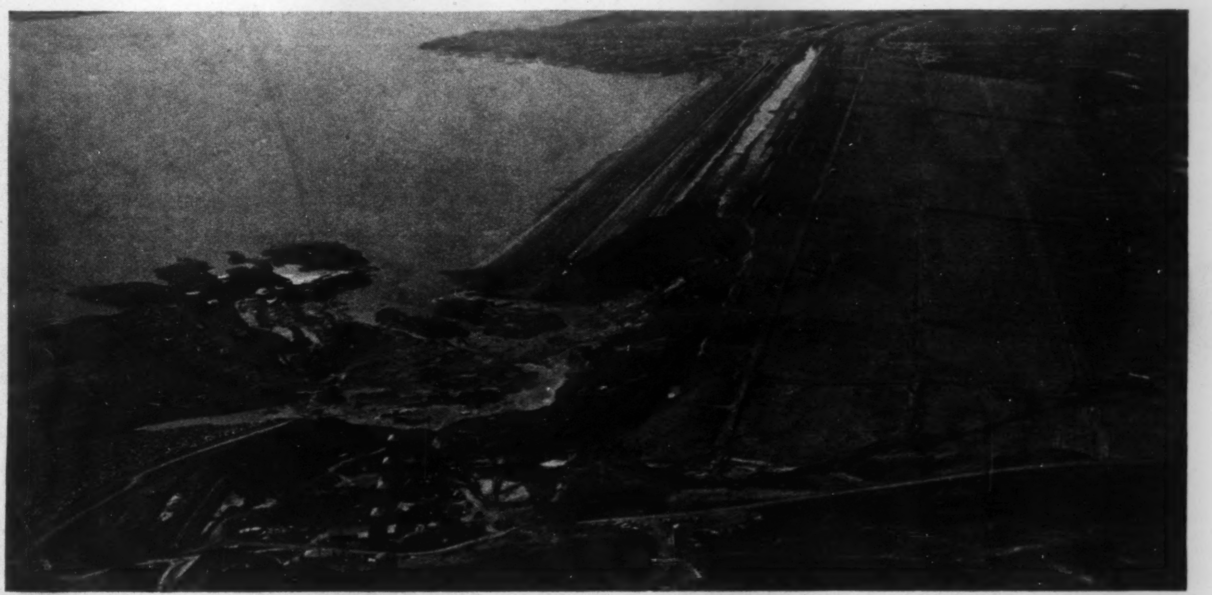

Fig. 1. **Airview of Fort Peck Dam immediately after the slide. As water stood about 65 ft. deep in the reservoir, the lower part of the slide material cannot be seen. The larger blocks of material showing above water farthest from the face of the break are sections of the upstream face, still covered with the heavy stone riprap that mantled the dam nearly up to final water line.**

At the site the river valley is a wide flat of glacial and river fill mainly sand and clay, on a substratum of "shale" or hard clay 80 to 100 ft. down, between bluffs rising 300 to 350 ft. high above the river. The material for building the dam by the hydraulic-fill method was pumped out of the valley bottom upstream and downstream of the dam site. The easterly and westerly parts of the dam were built first, to a height of about 150 ft., and later the intervening embankment across the river gap was built to the same height after diverting the flow through four tunnels driven through the east hillside. Finally, beginning late in 1937, the full length of the dam was carried up from this initial level.

On Sept. 22 work had proceeded to within 30 ft. of the crest, and the core pool and its confining banks were correspondingly narrow. Construction was going on at full capacity, to complete the hydraulic fill work by mid-November so that the dredging fleet could be dismantled. Four dredge units were pumping about 200,000 cu.yd. per day of solid material into the dam. Dam and core pool had been raised about 30 ft. in two months. A depth of about 65 ft. of water was impounded in the reservoir, though two months earlier the water had stood 19 ft. higher.

On the morning of Sept. 22 inspectors reported insufficient freeboard of the upstream bank above the core pool; the dredge pipe which rested on this bank appeared to be about 2 ft. lower than it should be. An immediate survey confirmed the observation; at Stations 15, 16 and 17 the pipe was only 3 ft. above pool level instead of at its proper height of 4½ ft. above pool, and Station 17 was the lowest point. When this result was reported (11:45 a.m.) a conference was called to meet at 1:15 in the afternoon at the point of greatest settlement, for discussion of the situation. The slide occurred just as the conference party was assembling.

At this time the core pool was at El. 2252, the reservoir water at 2117.50. Two lines of railroad track for quarry-rock placement and a roadway extended along the upstream berm at El. 2212, and quarry rock revetment was in place up to this berm. A pump boat, tender and a jetting barge were in the core pool near the east abutment, two draglines were working on the upstream bank crest near Station 17+50, and about 180 men were working in or near the area of the slide.

No movement of tracks other than normal settlement caused by passage of the heavy rock trains had been observed prior to the day of the slide. The structure of the dam, both core and banks, near the east abutment was normal. The core pool here had been held close to minimum width, and no sliding of shale from the abutment into the pool had been observed other than some surface raveling of the slope due to scour from the dredge discharge and a minor slide of the shale fill on the ridge west of the first gate shaft.

Eyewitness reports

Eyewitness reports gave the following composite account of the slide:

The core pool began to settle, slowly at first and then more rapidly, and about the same time cracks were observed on the upstream face 30 ft. below the crest. Then portions of the upstream shell nearest the pool began to slide into the sinking core pool, and some cracking and slumping took place also on the downstream beach. Simultaneously the main mass of the upstream shell, almost intact, was moving out into the reservoir, in a swing similar to that of a gate hinged at the east abutment, breaking away from the west or main part of the dam at about Station 27; the waters of the core pool poured out at the break.

A man at the pump barge, which was in the core pool near the east abutment, said that looking westward it appeared as if the fill to the west was falling into a big hole and that the hole progressed rapidly toward the pump boat; that as it reached the boat its forward end dipped down sharply and disappeared.

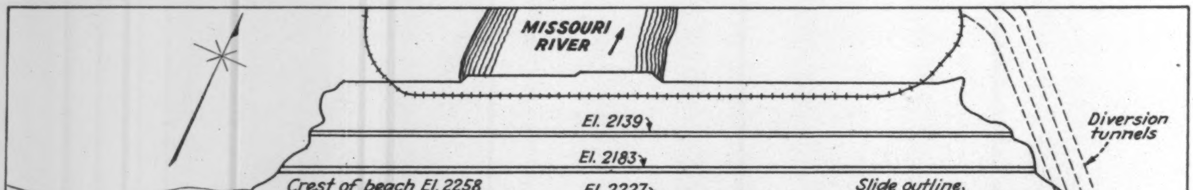

Fig. 2. **Fort Peck Dam, whose right end was damaged by a 5,000,000-yd. slide last September, is to be repaired by filling the break with new fill of much flatter slope. The map indicates the condition of the dam before the slide and the approximate outline of break and slide debris. The proposed reconstruction is shown in Fig. 3. The map was prepared from official data and views and is not part of the board's report.**

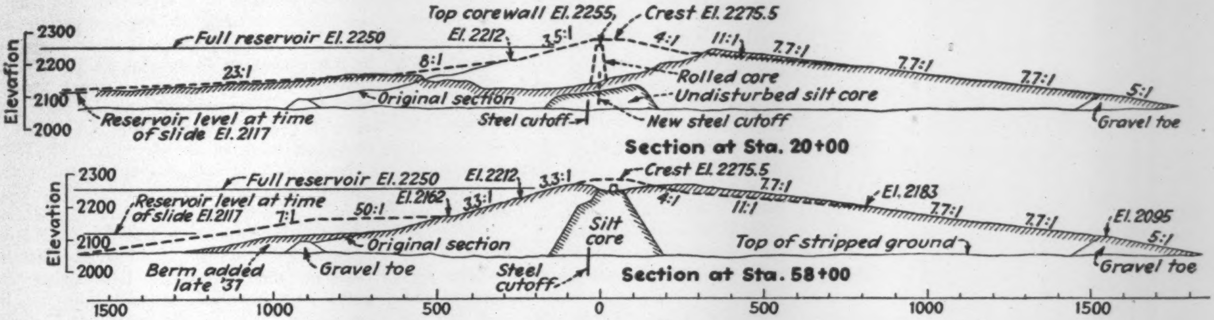

Fig. 3. Old as well as new parts of the dam are to be strengthened along the upstream face by giving the embankment a flatter slope or by adding a berm. Reconstruction outline is shown by heavy dash lines.

Estimates of the total time of movement of the slide indicate that it occupied about ten minutes. A total of 5,217,000 cu. yd. moved out into the reservoir pool; the maximum distance of movement was 1,200 ft. The upstream shell was partially destroyed for a length of 1,700 ft. (Station 10 to Station 27). Of the men in the slide area, 34 were carried along and 8 lost their lives.

The upstream shell of the section that slid out moved out almost intact, and after movement stopped the debris lay in a fan-shaped area roughly centering on the axis at the east abutment (see air view Fig. 1 and sketch plan Fig. 2). Large parts of the upstream face were exposed in almost horizontal position, still evenly covered with their quarry-rock revetment almost undisturbed.

Inquiry board's findings

An inquiry board of nine called to report on the slide and its reconstruction comprised William Gerig, W. J. Mead and Thaddeus Merriman of the original consulting board, and A. Casagrande, Irving B. Crosby, Glennon Gilboy, J. D. Justin, W. H. McAlpine and C. W. Sturtevant. Extensive investigations were made in the course of the inquiry, including soil sampling and testing, 30,000 ft. of core drilling (200 drill holes 2 in. to 6 in. in diameter, seven holes 12 in. to 36 in. in diameter drilled in prefrozen ground to show the undisturbed position and character of the material), two exploration tunnels about 150 ft. long in the hillside, and five shafts averaging 60 ft. deep in the dam outside the slide area.

As to the cause of the slide the board says:

> "After a careful consideration of all the pertinent data the board has concluded that the slide in the upstream portion of the dam near the right abutment was due to the fact that the shearing resistance of the weathered shale and bentonite seams in the foundation was insufficient to withstand the shearing force to which the foundation was subjected. The extent to which the slide progressed upstream may have been due, in some degree, to a partial liquefaction of the material in the slide."

For reconstruction in the slide area the board recommends building a narrow core of rolled impervious glacial till, 50 ft. wide at the bottom and 15 ft. at the top, surrounded by banks of either hydraulic fill or rolled fill (see section at Station 20 in Fig. 3) with upstream slope ranging from 3.5:1 at the top to 23:1 at the base.

> The board agrees that the shell of the reconstructed section may be built by hydraulic fill or rolled-fill methods, and recommends that the core be constructed of rolled impervious glacial till from the left abutment, to minimum widths of 15 ft. at El. 2255 and 50 ft. at El. 2120. Mr. Gerig dissents, believing that either a rolled-fill or a hydraulic-fill core would be satisfactory.
>
> The board recommends that the plan of bonding the old core to the new core by means of a single row of steel sheetpiling, as proposed by the district engineer, be adopted.
>
> The board approves the exploratory program outlined by the district engineer covering installation of piezometer pipes in the shale at both abutments for the purpose of measuring hydrostatic pressures. The board further approves the plan of the district engineer to install drainage wells at such points as the piezometer measurements indicate drainage to be desirable. The board recommends that the existing exploratory holes should be backfilled with pervious material.
>
> The board has considered in detail the question of stripping disintegrated shale from the east abutment and has examined the results of shear tests and stability analyses made by the district engineer. As a result of this examination the board believes that the flat slopes of the reconstructed section will result in shearing stresses in the disintegrated shale of such low intensities as to provide an ample factor of safety, and that, therefore, removal of the disintegrated shale is not necessary.
>
> The board has considered the question of grouting the fault zones in the shale in the east abutment, and approves the plan of the district engineer for further study of this problem.

As to those parts of the dam not affected by the slide, the board recommends that they be strengthened by adding an upstream berm (see cross-section at Station 58 in Fig. 3), built of material the same as or coarser than the material now forming the shell of the dam, and that this material be compacted.

> The board recommends that, in the construction of the berms on the upstream slope of the dam by hydraulic means, tractors be utilized on the beach to secure as great a degree of compaction as may be practicable without interference with hydraulic placing of the material. The board recommends that the use of these tractors be continued to such an extent as may be necessary to demonstrate whether or not a worthwhile additional compaction is obtained.

Above the present top of the dam (El. 2250) the embankment is to be completed by rolled fill. The dike which extends 11,000 ft. beyond the west end of the dam is considered satisfactory as built. Some hillside grading and minor structural changes are proposed in the vicinity of the entrance to the diversion tunnels to safeguard against hillside slides and to close the front entrance to the intake, blocked by the new slope.

Merriman recommends lowering reservoir level

Thaddeus Merriman, in a separate report, lays special stress on the part played by the weakness of the weathered shale on top of the hard blue shale, the slipperiness of the clay layer formed by the top of the weathered shale, and the hydrostatic pressure in the cracks and seams of the weathered layer. He recommends more extensive reconstruction than the majority report. He urges that all weathered shale within reach be removed from the abutments and the slide area, and that because of the impossibility of removing the objectionable material below about El. 2100 the spillway of the dam be cut down 50 ft. in height so as to lower the reservoir by this amount.

During the period of sixty days prior to the slide, the difference in level between the core pool and the water in the reservoir had increased from 83 ft. to 134 ft. Because of the open joints in the disintegrated and sub-firm shale, a substantial part of this pressure head was transmitted through them by the drainage water from the core pool as it passed through both the core and the shell. This pressure acting as an uplift under the upstream portion of the dam reduced the effective weight of the toe so that finally it was unable to restrain the slope above it.

Failure was thus initiated. The toe in the vicinity of Sta. 18 and range U 8 moved outward on the lubricated and disintegrated shale . . . The failure was distinctly in the disintegrated shale at depth under the dam . . . first, because it transmitted water pressures and, second, because it was slippery. All of the other materials involved behaved admirably. The core gave an excellent account of itself. . . . The shell material everywhere performed remarkably well. It was strong and exhibited a remarkable degree of solidity under most difficult circumstances. The frozen drill cores fully confirm the stability of this material. No blue unweathered shale showed any sign of motion. The valley fill materials above the weathered shale were badly deformed and disturbed, but the more sandy portions gave the best account of themselves.

The plans referred to constitute a reasonable solution of the problem, but, as a condition precedent to their execution, all wholly or partly disintegrated shale should be removed down to at least El. 2100. This removal must be so complete that the fill sections will everywhere rest on and abut against the blue shale from El. 2100 to the crest level of the dam.

As it will be impossible to remove the disintegrated shale from below El. 2100 some compensating measure must be adopted. I recommend that the pool level be dropped from El. 2250 to El. 2200 by lowering the spillway and removing the gates now installed. It will thus not be necessary to raise the main dam above its present elevation.

(Reconstruction is now going on in accordance with the recommendations of the board. An account of this work, as observed by Harold W. Richardson of *Engineering News-Record*, is printed below.—EDITOR.)

Reconstruction of Fort Peck Dam

H. W. RICHARDSON

Associate Editor, Engineering News-Record

Contents in Brief—Repairs to the slumped section of Fort Peck Dam have started with placing of a dry rolled core and a new sheetpile cutoff wall. Pumping of hydraulic fill to replace over 5,000,000 cu.yd. of embankment lost in the slide has also started. A second dredge is pumping fill into the new stabilizing berm at the upstream toe.

RECONSTRUCTION of the east section of Fort Peck Dam affected by the disastrous slide in the upstream embankment last Sept. 22 is well under way, as is also the placement of a wide berm to stabilize the upstream toe of the fill, all in accordance with procedure and design approved by the consulting board appointed last fall after the slide occurred.

In the heart of the slide area the lost hydraulic-fill core material is being replaced by a tight rolled-fill core of glacial till, bonded to the underlying original core by a new sheetpile cutoff wall. In this same area preparations are being made to rebuild the slumped embankment with dry material downstream from the new core, and one 28-in. dredge is already pumping fill into the big hole in the original embankment upstream from this core. Far down on the upstream slope of the undisturbed portion of the dam, at the edge of the present reservoir, pipelines from a second dredge are discharging material for the base of the new berm. Only two of the original four dredges, the *Jefferson* and *Missouri*, are being used in the reconstruction, and they are lost in the haze 5 miles down the Missouri River.

In a wide strip extending the full length of the undamaged section between reservoir level and proposed top of new berm, shovels and cranes are pecking away at the vast expanse of quarry rock and field stone riprap, loading the salvaged material onto trucks for transportation to new locations or to stockpiles for future use.

New rolled-fill core

At the east end of the dam the line of the axis and core has been straightened out from its original upstream curve to a straight extension of the main axis. Along this line, to replace the silt core carried out by the slide, is being built a new rolled-fill core of glacial till, 50 ft. wide at the average base level (El. 2120), tapering to 15 ft. wide at its ultimate top, El. 2255. From the top of the east abutment (Sta. 4+80) a steel sheetpile cutoff wall extends 2,090 ft. westward through the new core (Fig. 1). This sheeting, aggregating 162,320 sq. ft. and up to 135 ft. long, is driven either to shale foundation or 20 ft. into undisturbed silt core, and extends for 20 ft. upward into the new core.

Glacial till for the new core is obtained from a pit 1½ miles away, high on the west bank, and is hauled at the rate of 150 cu. yd. per hr. in trucks loaded by a 2-yd. shovel. The material is spread by bulldozers in 8-in. layers and is compacted by sheepsfoot rollers, trucks and tractors. Light tractors roll the edges. The till is proving ideal for the purpose, and packs to amazing hardness.

Escape of water from the long core pool at the time of the slide gouged out a ragged trough in the silt core, sloping toward the break. At start of placing the new core, all disturbed material was cleaned out of this trough down to firm silt core, which was cut to a long even slope. This slope now serves as a roadway for the truck haul (Fig. 2) and the stability of the original silt core is fully demonstrated by the way the road is standing up under the pounding of the heavy trucks. From the west end of the deep slide area at Sta. 25+70 the new core follows up the roadway slope, intersecting the top of the original silt core at Sta 36+00.

At the time of the slide the core was up to El. 2245; the rolled-fill core will be carried the full length of the dam to El. 2255. Some 290,000 cu. yd. of rolled fill will be required. During construction the dry core will be kept about 5 ft. above the adjacent embankment filling. As the core is built up, material from the adjacent shells is sluiced against the rolled fill to stabilize the toes of the core and to trim the embankment slopes preparatory to filling.

Dry excavation and fill

Except for the filling of the slide area, no more hydraulic fill will be placed on top of the dam. The present top of undisturbed embankment is about El. 2260, and this will be topped out to El. 2275 with a fairly steep-sided fill by excavation from the downstream face. Above El. 2183 the present downstream slope of 1 on 7.7 will be flattened out to 1 on 11 by excavating, the removed material going into the topping out and also into the slide area downstream from the core. This procedure involves moving 2,500,000 cu. yd. of material with a maximum depth of cut of 33 ft. Four 22-yd. carrying scrapers handled by seven tractors have just started this operation.

However, as even this large amount of material will be insufficient for both topping out and complete filling of the slide area downstream from the core, this latter section will be filled above El. 2215 by pumping, the excess water and fines being carried off through a glory-hole spillway in the downstream embankment.

Hydraulic fill

Late in 1937 and early in 1938, to stabilize the upstream toe of the closure section of the dam, a flat berm was pumped against the toe across the river channel, extending up the slope to El. 2112 from Sta. 30 to Sta. 70. This berm contains 3,568,000 cu. yd. Immediately after the slide last fall the berm was extended at the same elevation westward to the west abutment to prevent a possible foundation slip in that area. This required 1,307,000 cu. yd. of hydraulic fill, deposited below water, as the reservoir was at El. 2117.

After the slide, to protect the hole caused by the slide against possible flood rise of the reservoir, a ring levee upstream from the slide and with its top at El. 2162 was built by hydraulic placing. It required 2,364,000 cu. yd. of fill. This levee will be part of the new section.

As the cause of the slide has been definitely attributed to foundation failure, plans call for enlarging the present upstream berm by 8,526,000 cu. yd. of hydraulic fill west of the slide area, intersecting the original upstream slope at El. 2162. This berm will extend toward the reservoir on a slope of 1 on 50 to El. 2154, then will drop off to the valley floor on a slope of 1 on 7. It will be placed by a long trap pipeline carried near the outside edge of fill, supplemented by several ground pipelines discharging onto tables (Fig. 3). Glory-hole spillways will carry off the waste water and all fine materials, leaving only coarse sand in the fill.

Upstream from the new core the slide area will be filled by 3,974,000 cu. yd. of hydraulic material. A pump barge (Fig. 1) has been installed to take care of the waste water until the fill rises above the ring levee; glory-hole spillways will be used after that. The cross-section of the replaced fill varies, according to the contour of the slide debris, but the fill will be carried out beyond the tunnel intake portals at the elevation of top of portal walls (El. 2085), resulting in a net slope somewhat flatter than that of the berm to the west of the slide area.

Fig. 1. **Reconstruction of the Fort Peck Dam slide area gets under way. The dredge pipeline in the center is discharging hydraulic fill into the section between new core and the protection levee (right). The pump barge in right center will remove the waste water until the fill is high enough to permit installation of a glory-hole spillway. On both sides of the new sheetpile cutoff, at the left, a new rolled-fill core of glacial till is being built up.**

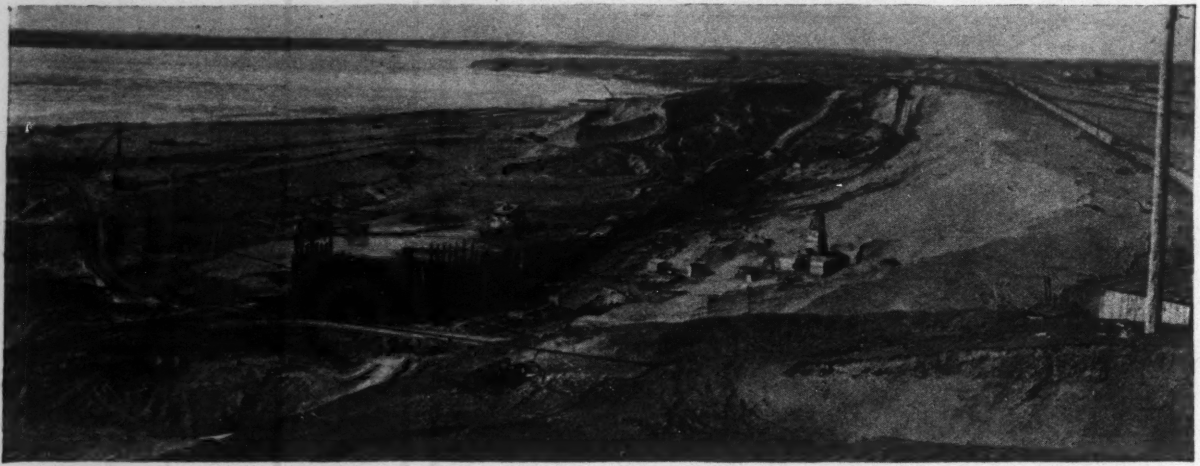

Fig. 2. **The extent of filling operations necessary to replace the material lost by the slide is shown in this view from the east abutment. To the left of the corewall the fill will be hydraulic; to the right, or downstream, it will be largely dry fill. Beyond the steel sheeting can be seen the base of the new core carried up the slope of the gouge made by the escaping core pool, now used as a haulage road for the core material being placed at the bottom of the hole.**

Some reconstruction of the portals will be necessary, but final plans have not yet been made. The shale bluff above the portals is being sloped back by excavating 738,000 cu. yd. of material.

Rock salvage

Thousands of tons of quarry rock and field stone riprap that had been placed on the upstream face below El. 2162 are being salvaged for use on the dike section to the west of the dam and for higher up on the main embankment (Fig. 4). Shovels and cranes load the reclaimed rock onto trucks for haul to stockpiles or direct to new location. To complete the riprapping, 280,000 cu. yd. of rock will be needed, of which 205,000 cu. yd. will come from the Snake Butte quarry 180 miles away, the rest from present salvage operations.

Flood possibilities

The possibility of floods raising the reservoir above the level of the protecting ring levee at El. 2162 has been given much study. However, authorities at the job consider the danger remote, for by the start of the flood season the first of June the slide area fill will be up to El. 2180. By June all four tunnels will be available for flood discharge, and with the reservoir at El. 2180 the tunnels can pass 68,000 sec.-ft.; at reservoir El. 2090 their capacity is 25,000 sec.-ft. The highest flood on record is 158,000 sec.-ft., but such a flow is virtually impossible this year because only little snow lies in the mountains. The March 1 snow survey indicated a runoff of 4,500,000 acre-ft. between Apr. 1 and July 30. Considering only 20,000 sec.-ft. discharge through the tunnels, the outflow from the reservoir in this period would be 4,800,000 acre-ft. Between El. 2090 and El. 2180 the reservoir has a storage capacity of 6,240,000 acre-ft., far more than the total expected flood inflow.

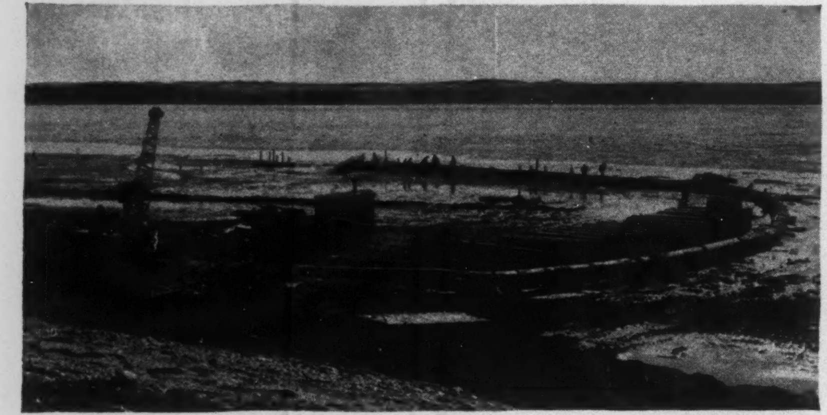

Fig. 3. **The ground pipeline here shown discharges onto tables to form the base of the stabilizing berm to be placed at the upstream toe of the undisturbed section of the dam. After the base has risen above the level of water in the reservoir the discharge lines will be carried on trestles and the waste water removed through glory-hole spillways.**

Program and direction

All of the hydraulic filling is expected to be finished this year, using only two of the four dredges available. Dredging began Mar. 15, and can be continued well into cold weather, as there will be no core pools to maintain. Dredge *Jefferson* is now operating with eight 2,500-h.p. pumps in its 24,500-ft. line, and is discharging an average of 2,000 cu. yd. per hr. Dredge *Missouri* is operating with six pumps, but three more will be added when the pipeline gets beyond five miles in length. Dry excavation and filling, completion of the dry corewall and riprapping will all extend into next year. Two of the 50-ft. ring gates in the tunnels are about complete.

Construction of the Fort Peck Dam is under the direction of Maj. Clark Kittrell, district engineer, Maj. C. N. Iry, director of operations, Capt. R. Lee, executive officer, Capt. C. H. Chorpening, in charge of construction, and C. S. Smith, superintendent on the dam.

Engineers Can Learn Fairness from Architects

***Contents in Brief**—The fairness of architects in preparing specifications is compared to that of engineers in like work to the disadvantage of engineers. This is the third of a series of observations by an engineer-contractor of long experience who remains anonymous in order to speak frankly.*

ENGINEERS as a body have shown great ability to set up standards. References to the standard specifications of the American Society for Testing Materials are used freely in their specifications. There is an urgent need for similar standardization in the specifications outlining the relationships between the engineer, the owner and the contractor. The American Society of Civil Engineers could well sponsor this work; it would help to raise the engineering profession to the same high plane in the supervision of work that has been reached by architects.

What architects have done

It is difficult to ascertain the value of construction work which is supervised by architects in normal times, but it is undoubtedly large. Statistics compiled by *Engineering News-Record* show for the period from 1925 to 1929 inclusive over ten billion dollars spent for the construction of public buildings and private industrial and commercial buildings. No doubt a large part of this work was designed and supervised by architects. A great deal of it was for public bodies. By far the greater part of it was done by lump-sum contracts. And judging from personal experience, the general conditions sponsored by the American Institute of Architects were used by most of the architects in their specifications.

These general conditions are now in the fifth edition of the A.I.A. specifications. They have received the approval of the Associated General Contractors and other contractors' organizations. They are fair to all parties to the contract. When incorporated in the specifications, the contractor is relieved from the onerous job of scanning each sentence carefully for a pitfall that might be his financial grave.

In the A.I.A. general conditions the powers of the architect are carefully linked up with his responsibilities. He has general supervision and direction of the work. He can stop the work when necessary to insure the proper execution of the contract. He must make decisions promptly on request of either the owner or contractor. His decisions in regard to artistic effect are final, if within the terms of the contract documents. Otherwise his decisions are all subject to arbitration. And since the architect is the interpreter of the contract and the judge of its performance, it is stated specifically that "he shall side neither with the owner nor with the contractor, but shall use his powers under the contract to enforce the faithful performance by both." It takes concerted action by the best and fairest minds of a profession to make such a statement.

What engineers do

A comparison of these standard and carefully compiled general conditions with those imposed by some engineers make one wonder if the latter were not copied from some ancient document born out of the dark days when public works was legitimate prey for crooked contractors and their political friends. The method was to write specifications so severe that no contractors, except those of the inner circle, would dare to bid. On any interloper all the unfair provisions would be exercised, or held over him as a club, until he made a financial peace offering to the proper person. To the favored bidder they were known to mean nothing.

Here are a few typical examples of what the long-suffering contractor must read every day:

> The contractor shall prosecute the work in such manner and at such places as the engineer may direct and shall conform to all his other instructions as to the modes of doing the same.
>
> Upon all questions concerning the execution of the work in accordance with the specifications, the measurements and estimates thereof, the decision of the engineer shall be final.
>
> Any work not herein specified, which may be fairly implied as included in this contract, of which the engineer shall be the judge, shall be done by this contractor without charge.
>
> All work under the contract shall be done to the satisfaction of the engineer, who shall determine all questions of quality, quantity and fulfilment, and shall determine the true intent and meaning of the plans and specifications and his determination shall be final and conclusive.

In the first place, the engineer should not have authority to stipulate the methods to be used by the contractor after the contract is signed. If he wants the work done in a certain way, he can so specify and the contractor can figure accordingly. But in general, the engineer is on safer ground to confine his specifications to results and to leave methods to the contractor.

As regards the authority of the engineer to make decisions as to the "intent" or the "true meaning" of his plans and specifications and to state that these shall be "final" or "conclusive," there are a number of reasons why it should not and cannot exist. If the contract documents are clear and distinct, no decisions will be needed. If they are not clear, the engineer's understanding or intent should not be the deciding factor in making a fair decision.

The real question is how the requirements of the plans and specifications should be interpreted by an experienced and competent bidder. And the objection also holds that no engineer should try to assume the powers which, in a free country, are conferred upon courts of law or upon legally constituted boards of arbitration.

What does it mean when the contractor is to do the work to the satisfaction of the engineer? If the work is done according to the plans and specifications, will the engineer be satisfied? If so, why make such a statement? If not, how much extra is the contractor to add to his bid to protect himself?

There is only one requirement that should be made of the contractor—it is that his work shall conform to the plans and specifications. If the plans and specifications are written as they should be, there will be no question about what will be required. It is not fair to imply to the contractor that, after he has complied with all known requirements, he still has to satisfy some individual or that he has to supply work and materials of unknown cost to make a plant work. It is well accepted in law that no contract can exist unless there is a meeting of the minds of the parties to the contract. No such meeting can take place if the plans and specifications do not explain exactly what the contractor must do in words which cannot be mistaken.

The tendency of engineers to reserve for themselves dictatorial powers of interpretation or to rely on such indefinite phrases as "to the satisfaction of the engineer" is prima-facie evidence that they distrust their own ability to describe and show the work properly and completely. Perhaps the profession should put forth more effort to help the students and younger men to develop this ability and the confidence that they have it. At least they can help to develop both by discouraging the young practitioner from trying to hide his shortcomings behind unfair phrases and to try to make the contractor, instead of the owner, pay for his mistakes.

Chemical Treatment of Sewage

APPLICATION of recent findings on the chemical coagulation of sewage made by the Division of Water and Sewage Research of the New Jersey Agricultural Experiment Station may be found helpful in the operation of treatment plants where chemical processes are in use. Reporting the results of these investigations at a meeting of the New Jersey Sewage Works Association, Willem Rudolfs, chief of the division, said the outstanding conclusions were:

Pre-sedimentation is generally neither detrimental nor helpful to clarification, except where lime and iron salts are used together. It may be slightly detrimental and has no effect upon coagulant demand.

Two zones of optimum hydrogen-ion values for clarification of sewage exist. The optimum values in these zones are in the neighborhood of pH 4.0 and pH 9.5.

Lime and ferric chloride can be added in either order, but addition of lime first is recommended.

Very rapid mixing of coagulant and sewage is necessary for most economical use of chemical.

In general inert materials are of little practical value when used in conjunction with coagulants.

Return sludge has some, though not extensive clarification value.

A flocculation time of from 15 to 30 min. is recommended under normal conditions.

Air used for stirring and mixing during flocculation produces desired results more quickly, but appears inferior to mechanical flocculation with paddles from the standpoint of clarification. High paddle speeds give more rapid results than slower ones, but not in proportion to speed or cost of operation.

Settleable solids in sewage are not concerned in determining the ferric coagulant demand. Non-settleable solids do not account for the major portion of the iron demand, but absorb ferric iron after the demand is satisfied. Hence, excess quantities are required for sludge dewatering.

The soluble fraction of sewage is responsible for the major part of the coagulant demand. Ammonia-nitrogen can be used as an index to determine the iron coagulant demand of domestic sewages, although addition or removal of ammonia from sewage does not affect the demand.

Up to the point of relatively complete clarification, ferric chloride is absorbed by the soluble matter, preventing the coagulation of all suspended matter when less than the total iron demand is added.

Boulder Dam Quakes Continue

Earth shocks in the area adjacent to Boulder Dam, on the Arizona-Nevada boundary, were first observed in September, 1936, and according to information received from the U. S. Coast and Geodetic Survey they have continued uninterrupted since that time (*ENR*, July 29, 1937, p. 178). During the four closing months of 1936, three sensible shocks occurred per month, on the average. In the following year the frequency of perceptible earthquakes increased greatly, with an average of 13 shocks per month during the year and maximum activity rising to 45 shocks in April and 42 in September. During 1938 the monthly average dropped to three shocks, while 1939 has had six shocks during the first three months.

Micro-shocks have been under observation by a Wood-Anderson seismograph set up in February, 1938, at Boulder City. Its record during 1938 showed 505 disturbances, or about 15 times as many as could be felt. It is expected that when a larger number of instruments can be set up in the Boulder Dam area, their records will make it possible to locate the centers of disturbance.

"It is not believed that similar disturbances have occurred at any other dam in this country," says L. O. Colbert, director of the Coast and Geodetic Survey. However, the size of Grand Coulee Dam and its reservoir has led to some speculation as to whether earth disturbances like those at Boulder Dam will occur when water is impounded, and plans are being made to carry on observations there.

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Hog Feeding Practiced At Sacramento

Sacramento, Calif., is now hauling garbage 12 miles to a hog ranch where it is spread in feeding fields. Different areas are used successively, thus allowing time for the hogs to work over the garbage. After a period they are driven into another section, the feeding ground is raked with an ordinary power-operated hay rake and the combustible refuse burned.

San Jose has followed a similar practice for many years with success.

Toll Superhighway System Rejected

Contents in Brief*—*Report to Congress by the Bureau of Public Roads finds against toll superhighway system; figures of construction and operating costs and anticipated toll receipts given; locations and capacity studies described; assumed design standards stated; substitute master plan of highway improvement recommended.

ASSERTING that a toll system of transcontinental highways is not feasible, the Bureau of Public Roads, in a two-part report, recommends for the consideration of Congress an inter-regional system of improved highways, modernized federal-aid roads, grade-crossing elimination and improvement of secondary feeder roads. The report is submitted in compliance with an order of the Federal Road Act of June 8, 1938. The order required the bureau:

> To investigate and to make a report on its findings and with respect to the feasibility of building, and cost of, superhighways not exceeding three in number running in a general direction from the eastern to the western portion of the United States and not exceeding three in number running in a general direction from the northern to the southern portion of the United States, including the feasibility of a toll system on such roads.

The routes selected for study on the basis of presumable traffic demands are indicated by Fig. 1.

Estimated cost and earnings

The construction of the six superhighways, says the report, "is entirely feasible from a physical standpoint." The estimated length is 14,336 mi. and the estimated cost of construction is $2,899,000,000 or an average of $202,270 a mile. The average cost varies from a maximum of $1,158,400 per mile for the section from Jersey City, N. J. to New Haven, Conn., to a minimum of $63,450 a mile for the section from Rupert, Idaho, to Brigham, Utah. For financing, maintaining and operating these two sections (1945–60) the estimated cost is respectively $66,560 and $5,700 a mile. The average charge for the whole system is $12,840 per mile per year or a total of $184,054,000 annually. These figures are based on estimates of a reasonable service life, good maintenance and a financing charge of 2.6 per cent annual interest and 2.24 per cent for retirement.

The total utilization of the superhighway system *in its entirety* by the most optimistic estimate for the period 1945–60 is 4,544 million vehicle miles of toll-paying traffic per year of which 3,635 million is accumulated by passenger cars and 909 million by motor trucks and buses. Per day, the figures are 12,450,000 vehicle miles for all vehicles, of which 2,490,000 vehicle miles would be by trucks and buses. This means on each mile of the system 699 cars and 175 heavy vehicles per day. These figures are system averages. On the section from Jersey City to New Haven the daily figures are 5,998 cars and 1,500 trucks and on the section from Spokane, Wash., to Fargo, N. Dak., they are 96 cars and 24 trucks and buses.

Toll rates per vehicle mile are figured at an average of 3.5c. for trucks and buses and 1c. for passenger cars. Since the ratio of heavy vehicles to passenger cars is on the average as 1 to 4 the average for vehicles of all descriptions is 1.5c. per vehicle mile. These rates were adopted after consideration of both lower and higher rates, either of which promised a smaller toll yield.

On the basis of the assumed toll rates, the estimated total collection for the maximum amount of traffic that can reasonably be expected to use the six superhighways will be $84,037,000 for the year 1960. For the 16-year period 1945–60 the total collection would be $1,154,236,000 or an average of $72,140,000 per year as compared with the annual total cost of $184,054,000 given previously. "It is therefore concluded," says the report, "that a direct toll system on these six superhighways, in their entirety, would not be feasible as a means of recovering the entire cost of the facilities."

Considering individual sections of the system, the report points out two, extending together from Philadelphia, Pa., to New Haven, Conn., 172 mi., on which the estimated revenue in 1960 is 109 and 104 per cent of the estimated cost for that year. On five other sections (in California, 91 mi.; Washington to Baltimore, 39 mi.; Boston to Portland, 134 mi.; Miami to Jacksonville, 326 mi.; and Baltimore to Philadelphia, 76 mi.), the anticipated revenues in 1960 would produce from 91.8 to 83.2 per

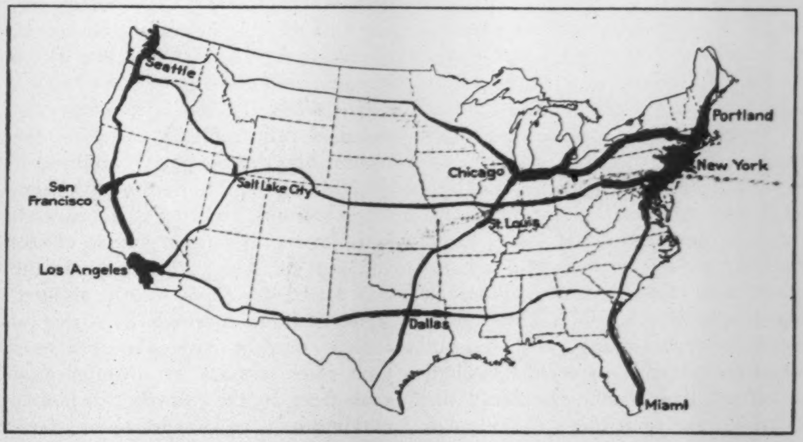


Fig. 1. Superhighway routes investigated as toll roads; width of shading indicates relative density of toll traffic estimated as of 1937.

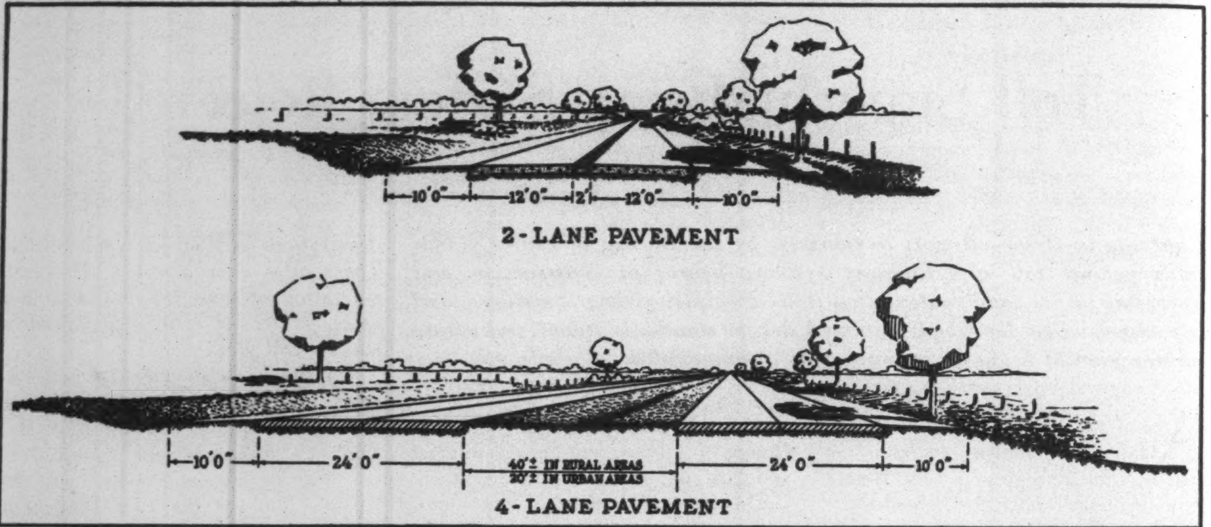


Fig. 2. Typical cross-sections proposed for superhighways; about three-fourths of the total mileage is two-lane pavement.

cent of the estimated cost. On 19 other sections the percentages run from 50.5 to 76.1 and on all other sections of substantial length between major controlling points the ratios of collections to costs are less than 50 per cent.

The report states that if, as an actual test of the feasibility of a limited mileage of toll roads, it is the desire of Congress to make provision for the construction of a section of highway of substantial length upon which there is a reasonable prospect of the recovery of the costs through tolls, it is recommended that such provision be made applicable to a highway from Washington, D. C., to Boston, Mass.

Location and capacity

Location of the routes, Fig. 1, keeping to the limits set by the law, was based on: (1) distribution in relation to geography and population, (2) accord with popular travel routes, (3) important terminal points and reasonably direct course, and (4) optimum location for the collection of tolls.

In all but two sections, totaling 94.2 mi., the detailed locations are entirely on new lines apart from existing roads; on this 94.2 mi. no other than the present location is topographically feasible. The chosen locations bypass cities and towns, but wherever possible pass close enough to attract their traffic. In detail the locations are such that: (1) control of access may be readily obtained wherever possible, (2) obstruction to the outward development of cities and interference with communication across the selected route are avoided to the greatest possible extent, (3) the cost of grade separation structures is reduced to the feasible minimum, and (4) a maximum feasible benefit of low land values is gained.

Fig. 1, besides being a route map, is a flow chart of the estimated 1937 toll traffic based on the general conclusion from careful analyses that not more than one-third of the vehicles that might use a typical free road of limited access could be regarded as potential traffic for the same road operated as a toll facility. The actual conversion factor used on various sections of the road ranged from 0.167 to 0.4. In estimating increase in future toll traffic over the toll traffic of 1937 the conversion factors used were 2.5 for 1960 traffic and 34.2 for the period 1944–60, assuming half the system completed and in operation by Jan. 1, 1944 and all of it completed by 1946.

The selected width of road for the assumed toll traffic is based on the recent highway capacity studies of the Bureau of Public Roads. From these capacity records, it is believed, says the report, that a volume of 400 vehicles per hour, with traffic in the two directions about evenly divided, is the maximum which it is safe to assume may be carried over a two-lane road without inconvenience at some time. By the records, this hourly maximum corresponds to a daily average of 1,500 vehicles. Sections of the selected system on which the daily traffic is expected to exceed 1,500 vehicles a day in 1960 are therefore planned to be more than two lanes wide. Four lanes are regarded as the minimum widening; the three-lane road is discarded. An average of 7,500 vehicles per day in both directions is considered a conservative figure for the capacity of a four-lane highway without inconvenience at any time.

Assumed design standards

Transverse sections of the planned two-lane and four-lane roadways are given in Fig. 2. Over three-fourths of the mileage consists of two-lane road located at one side to permit future widening to four lanes. The required right of way is 300 ft. in rural areas and 160 ft. in suburban areas. Designing for a normal maximum speed of 70 m.p.h., the maxima were set at 3 deg. for curves and 3 per cent for grades, with concessions in mountain topography to 4 deg. and 4 per cent. At 70 m.p.h., the distance required, says the report, to stop a vehicle, allowing 2 sec. for braking and a friction coefficient of 0.4, is 614 ft. *By inference this is the minimum sight distance worked to.*

On the roads as planned there are no intersections at grade, at no point will a driver encounter another vehicle crossing his path and at no point will he, except at especially designed accesses, encounter another vehicle entering the road. All underpasses are figured for a vertical clearance of 14 ft. and a transverse width that permits continuation of the shoulders and center separating strip at full width. On bridges under 100 ft., the center strip continues full width and the shoulders continue as sidewalks. On long bridges the center strip is narrowed to 6 ft. but no curbs are less than 2 ft. from the pavement edges. This indicates a 10-ft. center strip. Access points average 2.6 mi. apart in New Jersey and 79.4 mi. in Montana. Lighting at justified places, signs and landscaping are requirements.

Master highway plan

While the improbability of return sufficient to recover the costs of the indicated toll road system exists, says the report, it does not follow that there is not sufficient traffic to warrant and require facilities of higher standards than are provided at present. The report therefore outlines a master plan of highway improvement as follows: (1) the construction of a special, tentatively defined system (Fig. 3) of direct inter-regional highways, with all necessary connections; (2) the modernization of the present federal-aid system; (3) the elimination of hazards at railroad grade crossings and (4) an improvement of secondary and feeder roads, properly integrated with land-use programs.

The wholly new element of the plan is the inter-regional system. The need of this comes about from the need of wide modernization of the present highway system made necessary by changes that have occurred in the speed and volume of traffic. Specifically, these needed improvements include the reduction of excessive curvature on existing roads, the flattening of heavy grades; the opening of longer sight distances; a general widening of pavement lanes; the construction of additional lanes and separation of opposing traffic and possibly also lanes for the accommodation of slow-moving vehicles on heavy grades; grade separations at many intersections and protective devices at others; the abatement of dangerous roadside conditions, and a substantial improvement in the general directness of alignment between important objectives of the principal routes serving traffic movements of the larger ranges.

All these named improvements except one, it is stated, can be accomplished by local correction of and addition to the existing highways after the acquisition of new rights-of-way. The exception—the provision of more direct routes for long-distance inter-regional movements—will involve the construction of considerable lengths of new and more direct highways to be used by through traffic in place of existing indirect roads. Usually the existing road will remain in use for the service of the local traffic it was located originally to serve.

With the information provided by the state highway planning surveys it is possible to locate an inter-regional road system as indicated by Fig. 3. It is understood that Fig. 3 represents a schematic location subject to revision in final location for actual construction. In the location presented, the actual mileage is about 26,700. The alignment, design and construction of these roads will correspond to the standards previously described for the toll road system, varied slightly in concession to the more difficult and expensive locations.

Considering the outstanding problems of development, the report indicates three that call for immediate attention: (1) trans-city connections and express highways, (2) belt lines and bypasses, and (3) right-of-way problems.

Trans-city connections—All traffic maps show that the greater part of the highway traffic at a city entrance is an in-and-out movement of local generation. Of the remaining traffic of longer range there is a further considerable part destined to or originating in the city. These kinds of traffic cannot be drained off by bypass routes. Using as illustration the route from Washington to Baltimore, the report says: At Washington the bypassable maximum is 2,269 of a total of 20,500 entering vehicles; at Baltimore it is 2,670 of a total of 18,900 vehicles. "The remainder of the entering traffic in each case will not only continue into, but in large part penetrate to the very heart of the city, because that is where most of it is destined, and conversely it is at or through the same center that one must look for the source of most of the city-originated emerging traffic.

Under these conditions, which are typical, the only action which presents a really satisfactory solution, says the report, is the provision of adequate facilities for the conduct of the heavier entering traffic streams through the city at or near its center and on to appropriate exit points. This indicates trans-city express highways that may range from widening existing routes in some cases to a major operation of nothing less than the creation of a depressed or elevated road, examples of which are the depressed highway in St. Louis and the West Side Highway in New York.

Pointing out the serious right-of-way problems involved, the report concludes that "the construction of trans-city connections of the main rural highways and other express routes into the center of cities ranks first in the list of highway projects worthy of consideration by Congress."

Belt-line roads—Next to trans-city routes the report stresses as the most urgent need belt-line distribution roads around the larger cities and bypasses around smaller cities. The principal function of the belt-line road, as the report looks upon it, is not to route traffic around the city

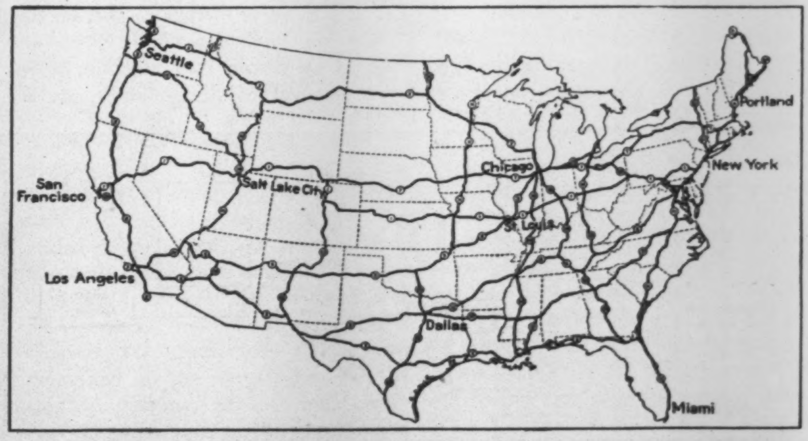


Fig. 3. Inter-regional highway system proposed with modernization of present roads, crossing protection and land-service road development, as a master plan of highway improvement.

but to distribute traffic to the city on any road to any other road needed to reach its city destination and to distribute outbound traffic in a reciprocal manner. But, the report emphasizes, if belt lines are to be and to remain the useful facilities they should be, "they will have to possess one feature that is present in none or virtually none of the circuit routes thus far built around urban communities, i.e., they will have to permit access only at their points of junction with the main routes approaching the cities and a very limited number of intermediate points. A so-called bypass route or belt line that is left open from the side at all points becomes in a very short time just another congested city street."

Right-of-way plan—Citing the various right-of-way obstacles to highway development that have existed and still remain, the report suggests that the problem would be simplified if some central federal agency were created to acquire land required for new or widened highways.

Sound basic data

For the wealth of basic data, available in great detail for the purposes of the required investigation, especially data concerning the volume, character, and range of traffic, the condition of existing highways, and the need for new facilities, the report is indebted to the statewide highway planning surveys of 46 states. The information furnished by these surveys made it possible within the limited time available to select the six superhighways described in this report with reasonable assurance that the selection made is probably the best that can be made, and to obtain the substantial concurrence, in the particular selection, of the responsible state highway authorities of all states. In fullness and in accuracy the facts supplied for consideration in the investigation are unmatched by the information elsewhere available. In the absence of these facts this report would necessarily be far less definite in its conclusions, and less dependable in its authority.

Preventing Gas Explosions In Sludge Digestion Tanks

C. E. Keefer

Bureau of Sewers, Baltimore, Md.

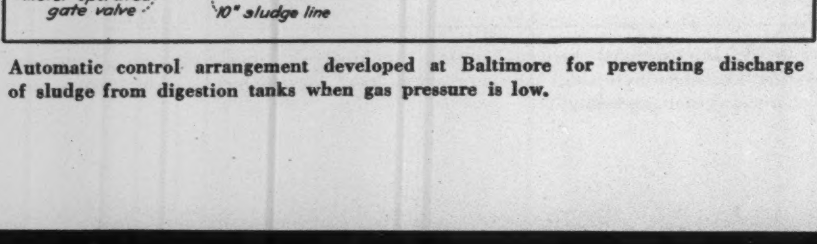
Where sludge gas is collected and utilized at sewage treatment plants, precautions must be taken to prevent explosions. At the Baltimore Back River disposal works an automatic control arrangement has been devised to reduce this hazard. At this plant there are two digestion tanks with fixed covers, each with a capacity of 200,600 cu.ft. The gas generated in these tanks flows through 6-in. pipe lines to rotary gas meters and thence to a 200,000-cu.ft. waterless gas holder.

In operating digesters with fixed covers there is always the danger of drawing air into the tank through the gas seals when sludge is withdrawn. This danger is minimized at the Baltimore installation as long as there is an appreciable amount of gas in the holder. Provisions have been made so that when sludge is removed from digester, gas will flow in the reverse direction from the gas holder and occupy a volume in the digester equal to the quantity of sludge removed.

If the gas holder should be empty or if a valve in the gas pipe from the digestion tank should be shut, air would be drawn into the tank upon the removal of sludge and possibly result in an explosive gas mixture. This danger is prevented by the installation of an automatic control consisting of a mercury pressure gage with electric contacts in the gas discharge pipe from each digester.

Should the pressure in the pipe drop to a predetermined point (slightly above atmospheric pressure), an electric circuit is opened and a bell rings, thus warning the operator of the low gas pressure. As lowered gas pressure would most likely be caused by the removal of sludge from the tank, a motor-operated gate valve has been installed in the sludge draw-off pipe from each digester. At the same time that the bell rings, this valve closes and prevents further withdrawal of sludge.

The Baltimore sewage disposal works are under the general supervision of Frank K. Duncan, chief engineer of the department of public works, and George E. Finck, sewerage engineer.


Alarm bell
Power supply
Power supply
U-tube with electric contacts
Relay
Gas holder
12" gas pipe
Gas boiler
6" gas pipe
Gas meter
Water seal
Suction well of sludge pumping station
Covered sludge digestion tank
Motor-operated gate valve
10" sludge line

Automatic control arrangement developed at Baltimore for preventing discharge of sludge from digestion tanks when gas pressure is low.

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Malaria Follows Irrigation

Very definite following of malaria on irrigation extensions has been observed in the lower Rio Grande irrigation area, according to Major J. A. LePrince of the U. S. Public Health Service. Breeding occurs in the borrowpits alongside the levees of the canal, the pits being filled by canal seepage through the levees. Shading the pit to prevent growth of algae has been proposed as a corrective; the adult mosquitoes will generally not lay eggs in water lacking in food supply.

Earth-Cement Mixture in Sacks Used for River-Bank Revetment

COL. H. A. FINCH

Corps of Engineers, Fort Sam Houston, Texas

***Contents in Brief*—A new application of cement-stabilized earth is being tried out where bank cutting reached a critical stage on the Rio Grande at Fort Brown, Texas, grain bags filled with the soil-cement mixture being used for bank revetment.**

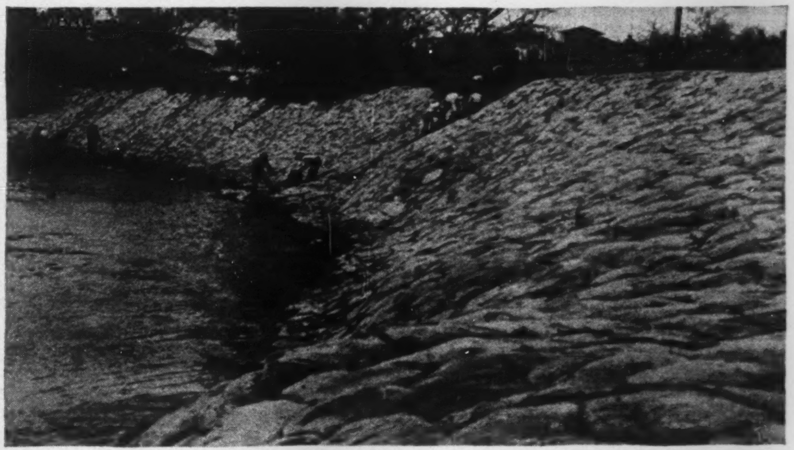


Fig. 1. Bank revetment made with earth-cement mixture in sacks, which is being used to check erosion at Fort Brown, Tex.

A BANK-PROTECTION PROJECT using an earth-cement mixture in lieu of riprap, was begun early this year on the Rio Grande not far above the mouth. Use of this material was suggested by the fact that the nearest suitable stone was 200 mi. away and rail freight, motor truck and hand delivery for 1- and 2-man stone brought the estimated cost for this material to $2 per sq.yd. Moreover, the large stones are frequently thicker than necessary, thus involving some waste. The use of mortar instead of stone, it was reasoned, would permit moulding to just the thickness desired. Although cement-stabilized soil could not be expected to resist heavy abrasion or long continued wave action, it seemed suitable for this particular location because of the short duration of flood-stages. Accordingly, 1,000 ft. of the river bank was protected in this way. If expected results are attained the method should be useful elsewhere. The test will come this year with the midsummer floods.

An economical feature of this material is that the mix can be proportioned so that just enough cement is used to hold it together in the currents to be resisted and it can be laid in as thin a layer as desired.

Other attempts to protect the river bank at Fort Brown have failed. A succession of groins, retards or brush mattresses weighted with concrete have been undermined or carried away and for 70 years the river has gradually cut away high ground and advanced toward the post until in 1938 the flood-stage levee rested against the foundations of the post headquarters building.

Requirements were simplified by the fact that the high stages at which most of the bank cutting is done, seldom last more than two days. From low water to flood stage the rise is about 26 ft. Floating trees sometimes constitute a menace but ice is not a factor; current velocities reach 3 to 3½ m.p.h.

It was decided to place the earth-cement mix in sacks rather than as a continuous paving partly to facilitate tamping but mainly to avoid danger of arching; i.e., to permit individual units to slip into holes caused by scouring and thus to prevent cutting. A few sacks can be added at low water each year to patch any holes that may develop.

A WPA crew of one foreman and 17 laborers was used. Four men cleared the bank of debris and smoothed it, the remainder did the mixing, sacking, placing and tamping. Cement and earth were mixed on a platform, first dry and then wet; the water added was 20 per cent by weight which produced a mortar with the characteristics of stiff mud. The earth had a high clay content and a little sand. It was used just as it came from the nearby borrow-pits, without screening. The only pretreatment was to break lumps larger than 1 in. in diameter. As each sack was filled it was placed and tamped with hand tampers of the type used in street paving. Care was taken in the tamping because compaction is believed absolutely essential.

Each sack weighed 75 to 100 lb. and was tamped to a thickness of about 6 in. This thickness was based on laboratory tests which indicated that a mixture containing 8 per cent cement would resist running water for 7 days or more. The 17-man gang mixed, placed and tamped 40 batches of mortar in a working day of 8 hr., each batch containing one sack of cement and producing 12 to 17 grain sacks of mortar, depending upon the cement content. The 8 per cent mix was used for the lower slopes of the bank; for facing and topping the levee crowning the bank, a 6 per cent mix was used. As it was impracticable to tamp the mixture under water, the lower courses were laid in the water at a low-river stage using sacks filled and tamped the day before placement.

The overall cost was 74¢ per sq.yd., not including sacks. Of this total 24¢ was for cement, and 50¢ for labor on the 8 per cent mix. (In the 6 per cent mix the cement charge fell to 18¢ per sq.yd.) Labor in clearing away debris and smoothing up the surface to receive the sacks was 4¢ per sq.yd.

Strength of Bolted Timber Joints

JOHN A. SCHOLTEN

Associate Engineer, U. S. Forest Products Laboratory, Madison, Wis.

THE STRESS DISTRIBUTION under a bolt in a wood member has always been a matter of conjecture, and methods of determining the loads by assuming a stress distribution have led to many widely different results. A brief item on the design of timber splices (*ENR*, Aug. 18, 1938, p. 216) incorporates such an assumption, which is valid only under certain limited conditions, and the formula proposed in that article as well as other general formulas does not cover the entire range of bolt design. In connection with this problem of bolt bearing a comprehensive series of strength tests of ordinary bolted timber joints has been made at the Forest Products Laboratory for all ratios of length of main member to bolt diameters in different directions to the grain, using the basic stress for the different wood species and taking into account the variation of the average stress under the projected area of the bolt with the *L/D* ratio as determined from test.

This method for determining the safe loads for bolts was presented, together with the results of the tests, in U. S. Department of Agriculture Technical Bulletin No. 332, "The Bearing Strength of Wood Under Bolts," which was issued in October, 1932. The safe loads for the bolts as determined by this method are presented for the first time in the accompanying table.

The values given are for bolts bearing both parallel and perpendicular to the grain of the wood and spaced and aligned correctly. For sizes other than those listed in the table, approximate loads may be obtained by interpolation, and the loads for bolts acting at various angles to the grain between these limits can be obtained by the use of the Hankinson formula, a graphical solution of which is given in the article immediately following.

The details of design required in the application of the values given in Table I may be briefly summarized as follows:

1. A load applied to only one end of a bolt, perpendicular to its axis, may be taken as one-half the symmetrical two-end load.

2. The center-to-center distance along the grain between bolts acting parallel with the grain should be at least four times the bolt diameter. The bolt nearest the end of a timber should be at least seven times the bolt diameter from the end of the timber for coniferous woods and five times

TABLE I — SAFE LOADS FOR COMMON BOLTS

(Lb. per bolt) [1]

Data by U. S. Forest Products Laboratory

Bolts bearing parallel to the grain [2]

Size of bolt (In.)	Thickness of main timber (In.)	Softwoods			Hardwoods		
		Group [4] 1	Group 2	Group 3	Group 1	Group 2	Group 3
½	1	400	500	650	462	600	750
	1½	600	750	966	694	900	1,114
	2	796	974	1,203	920	1,169	1,388
	2½	954	1,104	1,300	1,103	1,325	1,500
	3+	1,026	1,136	1,310	1,186	1,365	1,510
⅝	1	500	625	812	578	750	938
	1½	750	938	1,215	867	1,125	1,402
	2	1,000	1,245	1,595	1,156	1,495	1,840
	2½	1,244	1,520	1,880	1,437	1,825	2,170
	3	1,445	1,696	2,018	1,671	2,036	2,328
	3½	1,580	1,770	2,041	1,826	2,125	2,358
	4+	1,605	1,780	2,048	1,856	2,135	2,360
¾	1½	900	1,125	1,462	1,040	1,350	1,688
	2	1,200	1,500	1,942	1,388	1,800	2,240
	2½	1,500	1,868	2,380	1,735	2,240	2,746
	3	1,790	2,190	2,705	2,070	2,630	3,120
	3½	2,035	2,405	2,870	2,351	2,885	3,312
	4	2,230	2,540	2,940	2,580	3,048	3,394
	4½+	2,310	2,560	2,950	2,671	3,070	3,400
⅞	2	1,400	1,750	2,275	1,620	2,100	2,625
	3	2,100	2,609	3,310	2,428	3,132	3,820
	4	2,730	3,255	3,900	3,156	3,906	4,500
	5	3,115	3,478	4,012	3,602	4,174	4,630
	6+	3,150	3,484	4,012	3,640	4,180	4,630
1	2	1,600	2,000	2,600	1,850	2,400	3,000
	3	2,400	3,000	3,860	2,775	3,600	4,452
	4	3,182	3,898	4,810	3,680	4,675	5,550
	5	3,818	4,410	5,200	4,410	5,300	6,000
	6+	4,110	4,550	5,240	4,750	5,460	6,042

Bolts bearing perpendicular to the grain [3]

Size of bolt (In.)	Thickness of main timber (In.)	Softwoods			Hardwoods		
		Group [4] 1	Group 2	Group 3	Group 1	Group 2	Group 3
½	1	126	168	231	147	210	336
	2	252	336	462	294	420	672
	3	378	504	693	441	630	970
	4	504	646	813	588	740	1,008
	5	536	......	......	626	......	....
⅝	2	285	380	522	332	475	760
	3	428	570	784	498	712	1,140
	4	570	760	1,040	665	946	1,415
	5	713	922	1,150	832	1,045	1,425
	6	760	......	......	888	......	....
¾	2	317	423	582	370	528	846
	3	476	635	873	556	794	1,270
	4	634	846	1,164	740	1,058	1,680
	5	793	1,056	1,434	925	1,304	1,905
	6	952	1,220	1,535	1,110	1,395	1,903
	7	1,020	1,230	......	1,189	......	....
⅞	2	350	467	642	408	583	933
	3	525	700	962	612	875	1,400
	4	700	933	1,284	817	1,167	1,867
	5	875	1,167	1,604	1,021	1,458	2,284
	6	1,050	1,400	1,885	1,225	1,714	2,475
	7	1,225	1,570	1,981	1,429	1,801	....
	8	1,306	1,583	......	1,524	......	....
1	2	381	508	698	445	635	1,015
	4	762	1,016	1,396	890	1,270	2,030
	6	1,144	1,525	2,095	1,334	1,905	2,932
	8	1,525	1,954	2,460	1,780	2,236	3,050
	10	1,620	......	......	1,892	......	....

[1] These values apply to seasoned timbers used in a dry, inside location. For timbers occasionally wet but quickly dried, use three-fourths of the load listed; if damp or wet most of the time, use two-thirds of the load listed.

[2] These loads are for joints with metal splice plates. When wood splice plates are used, each one-half the thickness of the main timber, 80 per cent of these loads should be used.

[3] These loads apply for both wood and metal splice plates except that the safe load perpendicular to the grain should never exceed the safe load parallel to the grain for any given size of bolt or quality of timber.

[4] For species of wood included in each group, see Table 2.

TABLE II — CLASSIFICATION OF WOODS

(Numbers correspond to groups for which loads are listed in Table I.)

Softwoods:	
1	Cedar, northern and southern white Fir, balsam and commercial white Hemlock, eastern Pine, ponderosa, sugar, northern white, and western white Spruce, Engelmann, red, Sitka, and white
2	Cedar, Alaska, Port Orford, and western red Douglas fir (Rocky Mountain type) Hemlock, western Pine, red
3	Cypress, southern Douglas fir (Coast Region) Larch, western Pine, southern yellow Redwood Tamarack
Hardwoods:	
1	Ash, black Aspen and largetooth aspen Basswood Birch, paper Chestnut Cottonwood, black and eastern Poplar, yellow
2	Elm, American and slippery Gum, black, red, and tupelo Maple (soft) red and silver Sycamore
3	Ash, commercial white Beech Birch, sweet and yellow Elm, rock Hickory, true and pecan Maple (hard), black and sugar Oak, commercial red and white

for hardwoods, when the joint is under tension. When the joint is in compression, the end margin may be four times the bolt diameter for both conifers and hardwoods. Any decrease in these spacings and margins would decrease the load about in the same ratio. When cross bolts are used, the full value of the loads may be applied with half the margin.

3. The edge margin should be at least 1.5 times the bolt diameter. This, however, will usually be controlled by the common practice of having an edge margin equal to half the distance between bolt rows and the area requirements at the critical section. These area requirements are that the total bearing area under all the bolts should not exceed 55 per cent of the cross-sectional area of the member for coniferous woods and 50 per cent for hardwoods. Staggering should be avoided because of the tendency of the failure to run from hole to hole across the member.

4. For bolts acting perpendicular to the grain, the margin between the edge toward which the bolt is acting and the center of the bolt or bolts nearest this edge should be at least four times the bolt diameter. The margin at the opposite edge is relatively unimportant. The minimum center-to-center spacing of bolts in the across-the-grain direction for loads acting through metal splice plates need only be sufficient to permit the tightening of the nuts.

Bearing Strength of Wood At Angle to the Grain

J. A. Newlin

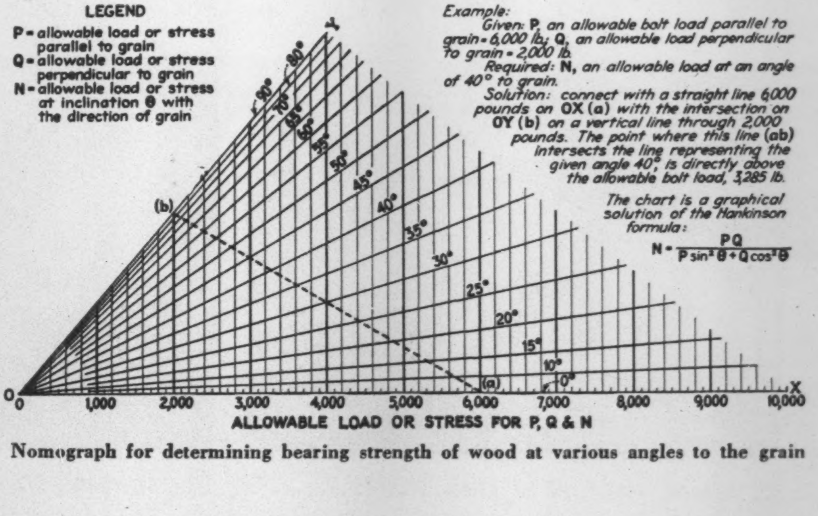
U. S. Forest Products Laboratory, Madison, Wis.

THE COMPRESSIVE STRENGTH of wood depends on the direction of the grain with respect to the direction of the applied force. It is highest parallel to the grain and lowest perpendicular to the grain, and for other angles has intermediate values. The ratio between the values perpendicular and parallel to the grain are not the same for different species of wood and also vary with the method of applying the load. For example, the basic stress of Douglas fir is 1,466 lb. per sq.in. parallel to the grain and 325 lb. perpendicular to the grain, while for oak these respective values are 1,333 and 500. The safe load on a 1-in. bolt in a 6-in. Douglas fir timber is 5,240 lb. parallel to the grain and 2,095 lb. perpendicular to the grain, as shown in Table I of the preceding article.

On account of this variation in the magnitude and relationship of the compressive strength parallel and perpendicular to the grain, the determination of the proper value for intervening angles has always been a difficult problem in timber design. To present values in tables for all the conditions would be impracticable. The bearing values for intervening angles, therefore, are usually obtained from the values parallel and perpendicular to the grain by the use of the Hankinson formula. This, however, involves a separate calculation for each individual condition and in order to provide a more convenient method the accompanying nomograph, based on the formula, has been developed by John A. Scholton of the Forest Products Laboratory.

The nomograph is based on the Hankinson formula, which is considered most applicable by the Forest Products Laboratory.

By means of this nomograph the stress or load for any intervening angle can be obtained from the stress or load parallel and perpendicular to the grain without any calculation. The symbols in the chart are represented by allowable loads or stresses but the formula is applicable for loads or stresses generally. The intercepts on any vertical line are proportional to $\sin^2\Theta$ from 0 to 90 deg. The scale of the chart was chosen primarily for convenient use with bolt loads, as given in the preceding article, but for greater or lesser values or for different units, the magnitude of the scale can be adjusted to obtain greater accuracy without affecting the chart's applicability.



LEGEND

P = allowable load or stress parallel to grain

Q = allowable load or stress perpendicular to grain

N = allowable load or stress at inclination θ with the direction of grain

Example:

Given: P, *an allowable bolt load parallel to grain = 6,000 lb.;* Q, *an allowable load perpendicular to grain = 2,000 lb.*

Required: N, *an allowable load at an angle of 40° to grain.*

Solution: connect with a straight line 6,000 pounds on OX (a) *with the intersection on* OY (b) *on a vertical line through 2,000 pounds. The point where this line* (ab) *intersects the line representing the given angle 40°, is directly above the allowable bolt load, 3,285 lb.*

The chart is a graphical solution of the Hankinson formula:

$$N = \frac{PQ}{P\sin^2\theta + Q\cos^2\theta}$$

Nomograph for determining bearing strength of wood at various angles to the grain

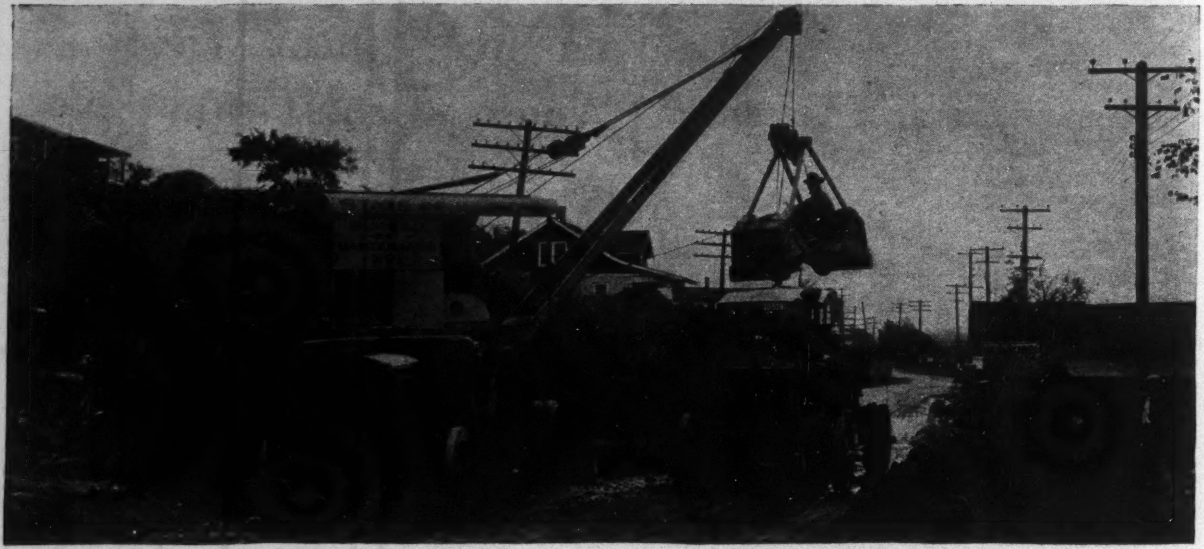


FIG. I. CLAMSHELL AND TRUCKS CLEAR AWAY A SLIDING BANK (ILLINOIS).

Road Upkeep—A Housekeeping Job

C. S. Hill

Associate Editor, Engineering News-Record

Contents in Brief—The second of a series of articles that picture and explain outstanding activities that keep transport moving on the highways. This article describes the primary element of road maintenance, housekeeping, the performance regularly of many inconspicuous tasks that keep the road in order.

Mention was made in the preceding article (*ENR*, April 27, 1939, p. 61) of road upkeep as a housekeeping job. With all credit to its special tasks of snow removal and landscaping, that are described in succeeding articles, just plain everyday housekeeping is the main duty of highway maintenance. In roadwork as in the home, housekeeping is the repeated and orderly performance of many small operations. About the only way to indicate these operations is to picture some of them and to list the others; individual description would exceed all reasonable article space.

The housekeeping force

Organization for road upkeep has already been stressed but is emphasized again here, and again a single state is selected as an example. Illinois is the state and C. W. Ross, engineer of maintenance, is the source of information; he supervises the work of 2,000 to 4,000 men scattered over

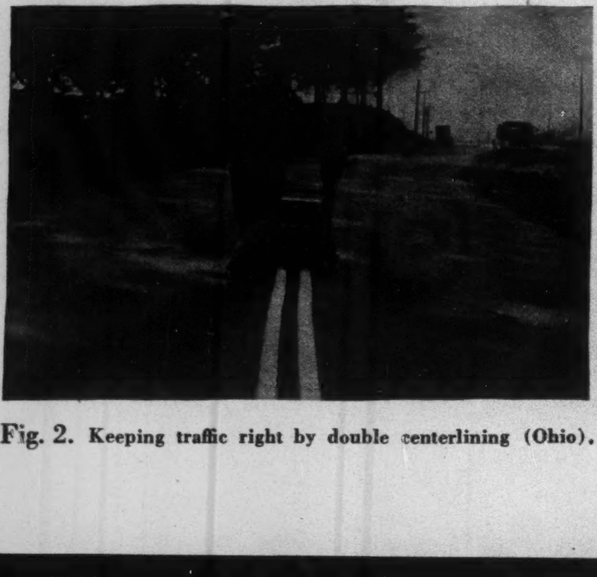


Fig. 2. Keeping traffic right by double centerlining (Ohio).

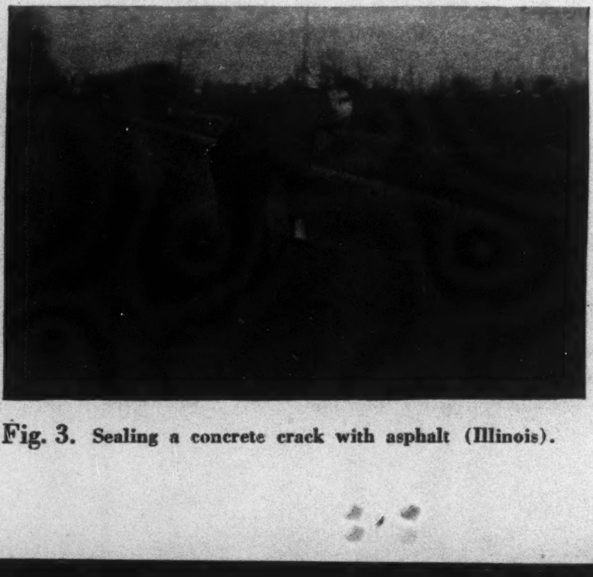


Fig. 3. Sealing a concrete crack with asphalt (Illinois).

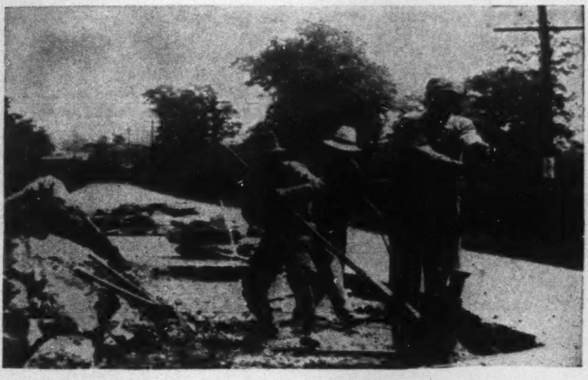


Fig. 4. Replacing a broken spot (Illinois).

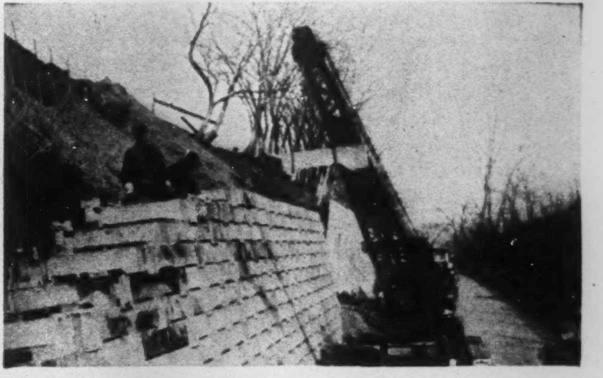


Fig. 8. Building crib wall of precast concrete (Illinois).

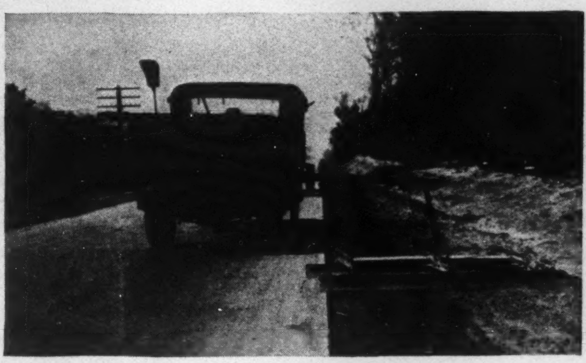


Fig. 5. Dragging an earth shoulder (Illinois).

Fig. 9. Guniting a loose stone wall (Illinois).

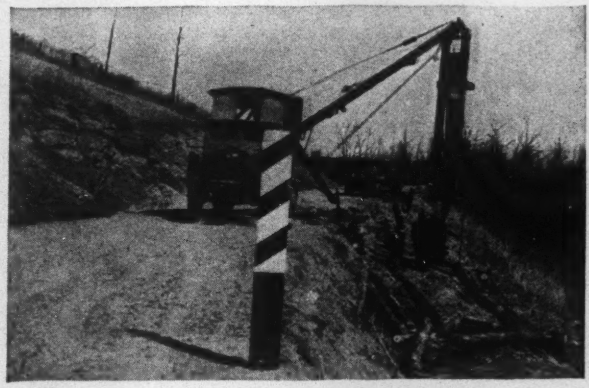


Fig. 6. Driving sheet to stop a slip (Ohio).

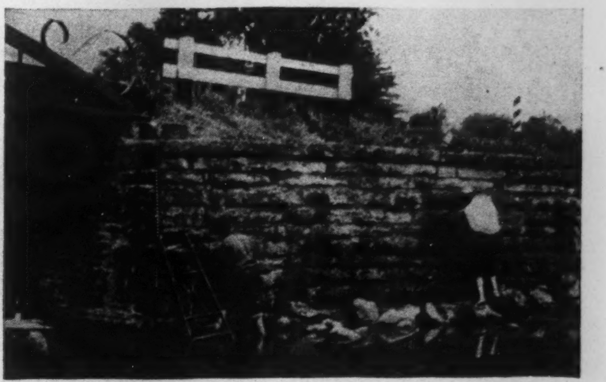


Fig. 10. Repointing an abutment wall (Ohio).

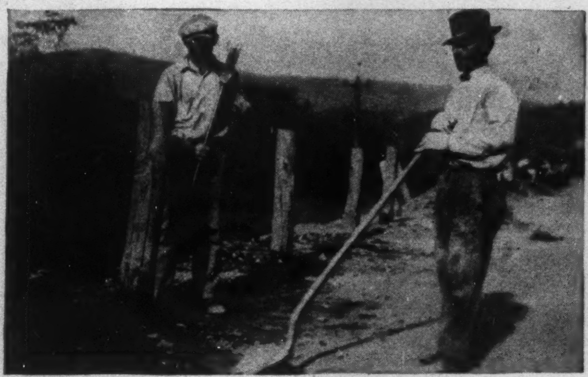


Fig. 7. Setting posts for guard rail (Pennsylvania).

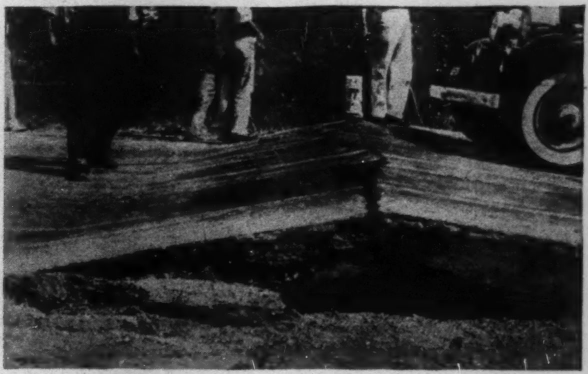


Fig. 11. Ready to cut out a blowup (Indiana).

more than 12,000 mi. of highways.

These highways are maintained by a combination of maintenance sections and gang maintenance. A section is 20 to 25 mi. of road, and each section is cared for by a salaried maintenance patrolman assisted by a helper who works on an hourly basis. A 1½-ton truck with a road drag, an asphalt heating kettle and necessary small tools are the equipment for the patrolman. From 8 to 12 patrolmen are grouped under the nominal direction of a supervising patrolman. Technically trained field engineers are assigned 500 or 600 mi. of highways over which they have general supervision of both supervisors, patrolmen and their helpers and such extra gangs as may be working in their territory.

Since the patrolmen are limited as to equipment and experience, each of the ten highway districts has several experienced maintenance foremen who have special gangs and equipment for performing heavy work which the patrolman is not equipped to handle. The special foremen are usually experienced along special lines of pavement replacement, as earth excavation, bridge painting or placing blacktop.

All of the field forces are responsible to and make their reports direct to each of the ten highway districts in which they work. The district maintenance engineer reports to the district highway engineer, who is a responsible administrative officer for each of the ten highway districts.

The tasks are many

This looks like a rather compresensive setup just for keeping roads in condition and it is, but there are 12,000 miles of roads, at least three miles to every man employed, and 4,000 times three miles of road present a lot of tasks. Mr. Ross jotted them down as follows:

Repairing pavements; repairing shoulders; cleaning and maintaining ditches and drainage structures; repainting bridges and guard fences; cleaning trash, debris and advertising signs from the highway; cleaning inlets, gratings, gutters and other highway drainage facilities. Cutting and mowing vegetation; removal of snow; reduction of ice hazards; guarding dangerous places during floods and immediate repair of damages incurred; care of highway rights-of-way, guard fence, culverts and other highway facilities; investigation and settlement of complaints of citizens dissatisfied with the condition or result of highway construction; gradual improvement of highway facilities to meet the more modern demands of traffic; care of equipment.

Noting the last item it may be said that the success of highway maintenance calls for a study of the various kinds of equipment and selection of units best adapted for the work. Even the occasional designing of special equipment and suggested modification of design of standard units is a part of the maintenance engineer's work in keeping the highways in good condition for traffic.

Then in states with older paved roads there is a constantly increasing task of revamping that comes short of reconstruction but includes minor additions and enlargements that will eke out accommodations for growing traffic and delay the time when a new road must be had. Illinois has a number of roads constructed 15 to 20 years ago, many of which carry heavy traffic. Gradual improvements

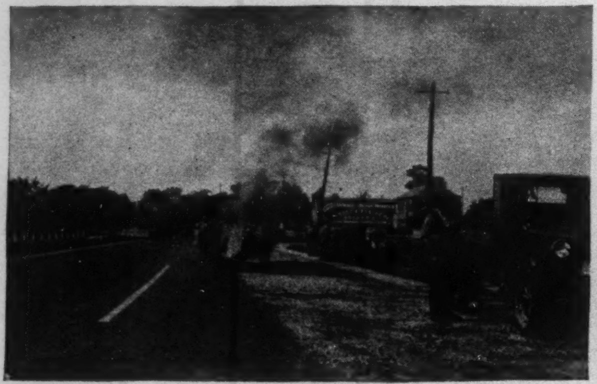


Fig. 12. Burning out a slippery fat spot (Ohio).

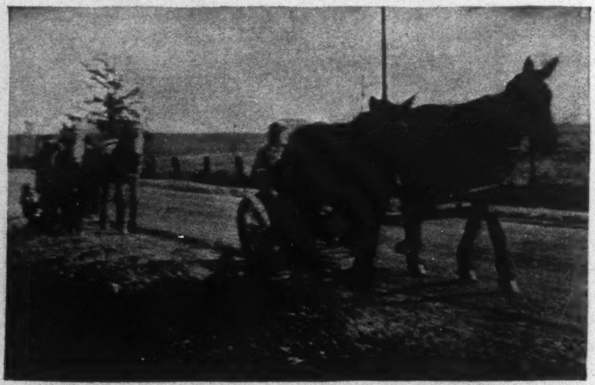


Fig. 13. Mowing weeds on earth shoulder (Indiana).

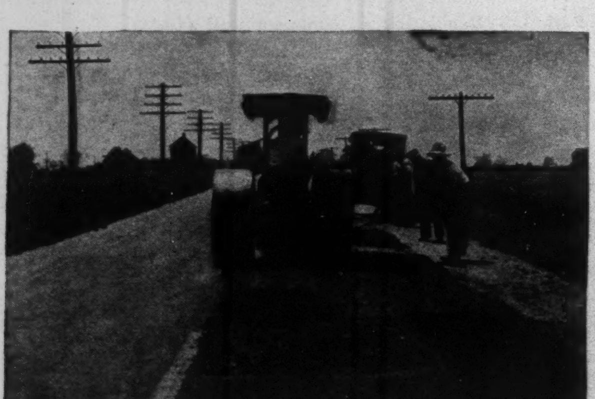


Fig. 14. Patching a worn pavement (Ohio).

Fig. 15. Raising low spots by mudjacking (Indiana).

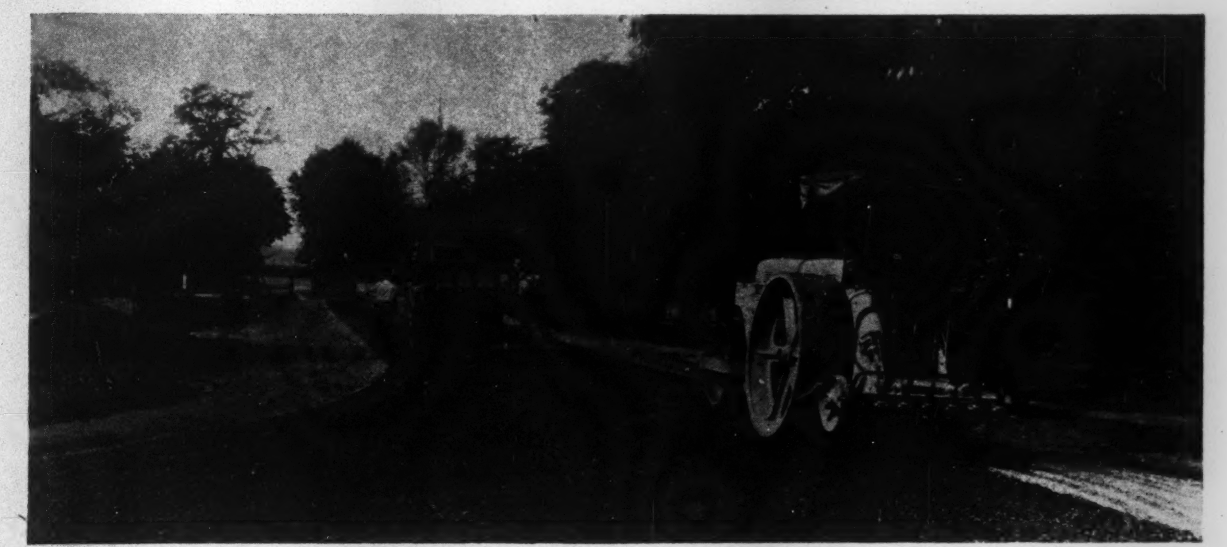


Fig. 16. Oiling, dragging and rolling stone base, a major operation but a routine of maintenance (Pennsylvania).

are being made on these old sections by widening culverts and small narrow bridges, constructing gutter, constructing blacktop shoulder surfaces on the inside of curves and tangents, removing hedges to prevent snow drifts and improving drainage.

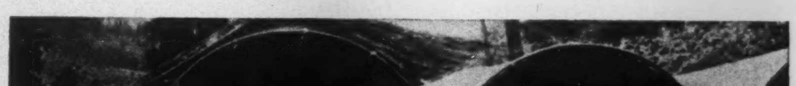
The maintenance engineer also has the obligation of studying highway design and its relation to the needs of traffic and its fitness for the type of country or soil on which it is laid. Where designs are found to be inadequate, it is a duty of the maintenance engineer to call this to the attention of the design and construction departments in such manner that improvements in future designs can be made.

Looking at the dozen pictures (a hundred could have been published) on these pages and counting the maintenance tasks listed, one gets a glimpse of why maintenance forces are thousands and the operations are hundreds. How are they all accounted for to insure that money and time are not wasted? The following article tells of the audits and checks that are employed.

"Storm Tops" Protect Men In Transit

PROTECTION from wind and weather is needed by workmen transported over the 15-mi. flume railroad maintained by the Pacific Gas & Electric Co. on its Stanislaus tunnel project in California. All hauling of men and materials is done on small flat cars 16 ft. long on which ordinarily there is no cover. For inclement weather it was desirable to provide some form of shelter for men making the trip to or from the job. This was accomplished by making up frames of ½-in. standard black pipe welded into the form of arched structures over which water-proofed canvas could be stretched and fastened with tie ropes.

Longitudinal benches provide seats for the men, the canvas is fastened shut at the forward end to keep out head winds and the pipe frame is bolted to the car deck for safety. In each of the "storm tops" about 20 men can be seated and as the frames are light, when not in use they can be lifted off the cars easily and set on a convenient support beside the track.



"Storm Tops" made of welded ½-in. pipe frame covered by waterproofed canvas, protect workmen riding on railroad flat cars. These are used on the railroad line shown on p. 500 of the issue of April 13, 1939.

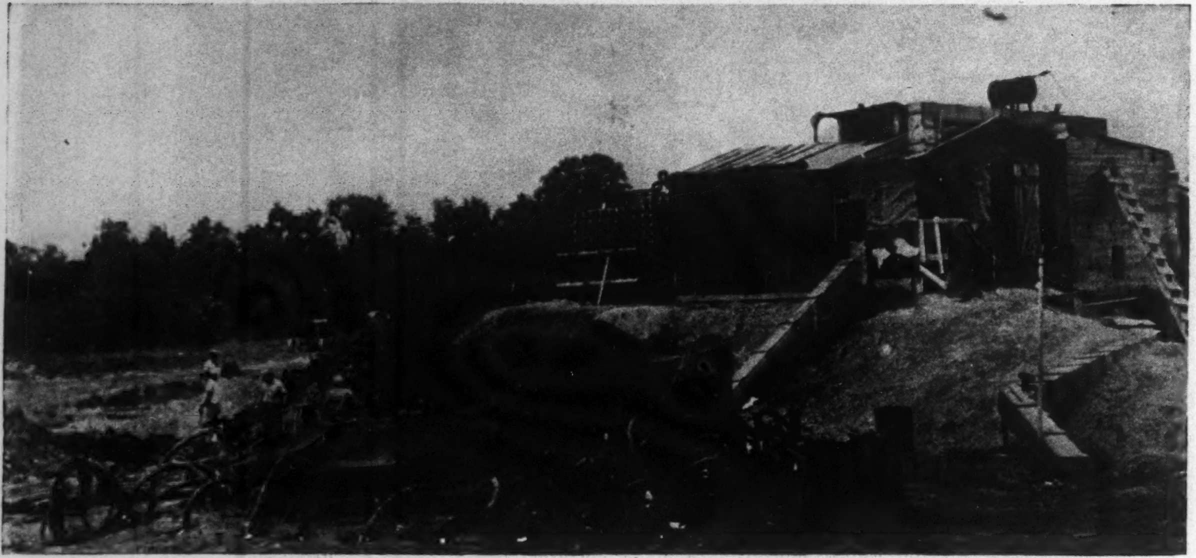


FIG. I. REFRIGERATING PLANT AND FREEZING SYSTEM FOR A WET SHAFT AT GILBERTSVILLE DAM.

A Wet Shaft Frozen Tight

H. B. Gough
Tennessee Valley Authority, Knoxville, Tenn.

***Contents in Brief**—A 20-ft. test shaft sunk 90 ft. by freezing water-bearing strata; refrigerating plant and freezing system illustrated and described; progress and performance records given; one of the few uses in recent times in America of freezing for underground construction.*

THE FREEZING PROCESS, little used in America since a generation ago, proved a real help in time of need last year in sinking a wet shaft at Gilbertsville Dam of the Tennessee Valley Authority. Seepage troubles, considered impossible to meet by other methods that permitted the purposes of the shaft to be served, were completely overcome by freezing. Indeed, so successful was the operation that engineers of the TVA look forward to the possibility of a very considerable extension of the freezing process in underground exploration and construction.

Shaft a giant test pit

The ground under the Gilbertsville Dam is limestone bedrock with about 50 ft. of overburden in the river channel and 90 to 110 ft. on the flood plain. In examining the subsurface conditions, it was decided that a large test shaft about 20 ft. in diameter sunk to bedrock would serve several purposes; it would check the accuracy of the drill samples of the overburden strata, it would disclose the condition of the foundation rock and permit diamond drilling from the bottom of the shaft at flatter angles than can be obtained from the ground surface and it would offer an opportunity to observe the behavior of steel sheetpiling driven to this depth. The test shaft also made it possible to observe (1) the effectiveness of rock and overburden grouting, and (2) the applicability of freezing as an aid in excavation to such depths.

It was decided to sink the shaft by driving a ring of steel sheetpiling into bedrock and then excavating within the cell thus formed, bracing the inside as excavation proceeded. By this means of progressive digging and bracing, the crew was able to reach within 14 ft. of bedrock when severe sand blows made it impossible to complete the excavation by this method. It was then that refrigeration was resorted to as a means of immobilizing the subsurface materials. Installation of the refrigeration plant was started Jan. 20, 1938, and completed Feb. 8. The plant was of the ammonia-brine type and its cycle was as is common in this type of plant. The more important detail is the circulatory system at the shaft.

Plant at the shaft

The freezing circuit at the test shaft consisted of a ring of 31 vertical pipe assemblies extending around the perimeter of the shaft about 12 in. out from the sheetpiling (Fig. 2). The individual pipe assemblies in the series were 27 in. apart and extended down to bedrock.

The first step in the installation of each freeze-pipe assembly was to drive to bedrock an outer casing, 3 in. in diameter and open at the bottom. This open casing made it possible to drill into bedrock so that the pipes actually carrying the cold brine could reach into the rock and contact and solidify any flow of groundwater

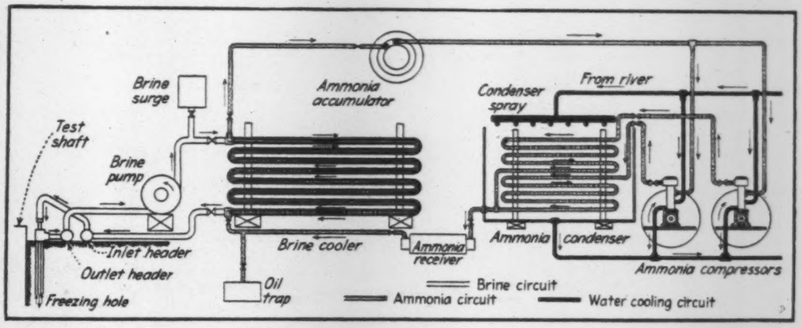


Fig. 3. Schematic diagram of the refrigerating circuits arranged for freezing wet strata at the test shaft.

occurring in small fissures in the rock itself; also it permitted the brine pipes to be removed for examination.

Inside this 3-in. outer casing was inserted a smaller 2-in. casing sealed at the bottom. These 2-in. pipes when first installed rested on the bottoms of the holes, from 1 to 1½ ft. above bedrock, while their tops projected 1 ft. above the ground surface. One end of a 2-in. tee was then threaded to the pipe, leaving the central outlet on one side and the "crossbar" of the tee standing vertically. A 1¼x2-in. bushing was then threaded to the top of the tee and a 1-in. pipe inserted through both bushing and tee down into the 2-in. pipe to a point about 6 in. above the sealed bottom. The top of this 1-in. pipe projected about 6 in. above the tee. The top of the bushing was then welded to the 1-in. pipe to make the joint watertight.

Two 4-in. circular headers were placed on the ground surface around the test cell and outside the circle of freeze pipes; a 1-in. pipe outlet nipple was welded opposite each freezing hole. Rubber hose was then used to connect each freezing hole to the headers, the supply or inlet header being connected to the 1-in. pipe extending above the tee, and the return or outlet header being connected to the outlet of the tee on the side of the 2-in. pipe. Four-inch pipes carried the brine from the cooler to the supply header and from the return header to the brine pump in the refrigeration plant.

The cycle of brine movement (Fig. 3) was relatively simple. From the brine cooler, it went to the supply or intake header, thence down the 1-in. pipe, to return upward through the annular space between the two sizes of freezing pipe to the outlet or return header, and finally back to the brine cooler.

The plant started on Feb. 9, 1938, and remained in continuous operation until March 28. An unsuccessful attempt to unwater the shaft on that day proved that the plant lacked capacity to overcome the losses caused by the wide fluctuations in groundwater levels. Another compressor was added, and sufficient additional coils were installed in the ammonia condenser and brine cooler to double the capacity of the plant. While these changes were made the original plant installation remained in operation. At the same time, the freezing holes were disconnected, one by one, and deepened so that the vertical freezing pipe assemblies extended about 5 ft. into bedrock.

This enlargement gave the refrigerating plant a nominal standard capacity of 46.5 tons, though this was limited by operating conditions to a theoretical capacity of about 28 tons. Altogether, the plant was operated for 219 days, during which time one compressor operated 151 days, the other the full 219 days.

Fig. 2. Uncovered shaft top showing circle of freezing pipes extending 90 ft. deep to bedrock; refrigerated brine circulating in pipes froze a tight ring around the shaft.

Fast freezing

The enlarged plant went into operation April 20, 1938, and it was evident that positive freezing action took place immediately. On May 16, the cell was successfully unwatered, and by June 15 excavation had been carried down to bedrock. A week later, however, when the temperature was raised inadvertently, due to drilling operations at the bottom of the shaft, a leak and consequent blow accompanied by surface subsidence occurred. This was repaired by locating additional freezing pipes in the vicinity of the leak. The cell was unwatered again on Aug. 23, and no further trouble was encountered.

The rock exposed at the bottom of the shaft proved to be a dense, black, siliceous limestone, with hori-

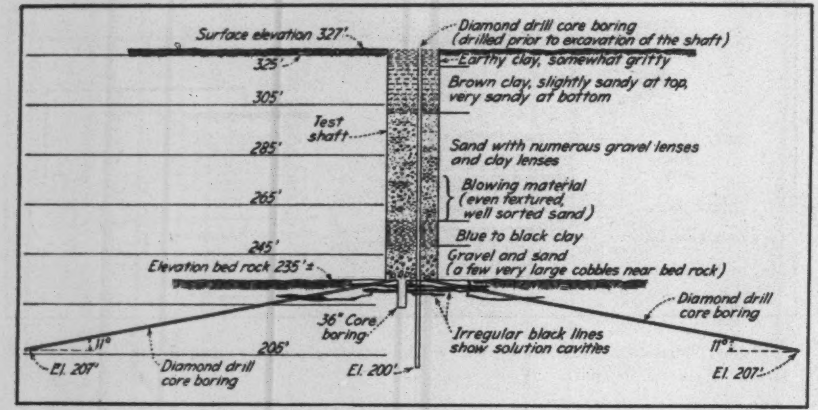

Surface elevation 327'
Diamond drill core boring (drilled prior to excavation of the shaft)
325'
Earthy clay, somewhat gritty
Brown clay, slightly sandy at top, very sandy at bottom
305'
Test shaft
285'
Sand with numerous gravel lenses and clay lenses
265'
Blowing material (even textured, well sorted sand)
Blue to black clay
245'
Gravel and sand (a few very large cobbles near bed rock)
Elevation bed rock 235'±
Diamond drill core boring
36" Core boring
Irregular black lines show solution cavities
11°
205'
11°
El. 207'
Diamond drill core boring
El. 200'
El. 207'

Fig. 4. Chart of material penetrated by the test shaft and its use for making flat-angle borings to explore bedrock foundation.

zontal bedding. Study of the bases of the piling disclosed six ruptured interlocks, which had caused the piles to leave the shape of the true circle. These openings, ranging from 1.7 to 3.2 ft., had been the means of ingress for the groundwater and mobile sands. Study of the ends of the piling revealed that all but two of the 50 piles had reached bedrock, and 25 had actually penetrated bedrock, some as deep as 5⅝ in., without material damage.

Operating data

About 1,500 gal. of brine were used in the brine system. The capacity of each freezing pipe was about 15 gal. Calcium-chloride brine having a Baume density of 25 deg. and a freezing point of —30 deg. F. was used. Brine of this density has a weight of 10.295 lb. per gal. and a specific heat of 0.69. This brine entered the 4-in. circular headers and was pumped back into the refrigeration plant at a rate of about 200 gal. per minute, or at a velocity of 5 ft. per second. If brine entered each freezing pipe at a rate of 7 gal. per minute (considering an average of 30 freezing holes to be in the circuit), the velocity of the brine in the internal 1-in. entrance pipe would be about 2.6 ft. per sec. and the brine returning through the annular space between the 1- and 2-in. pipes would travel about 1.1 ft. per sec.

Periodic temperature readings were taken of the brine, the atmosphere, the river water, both air and water inside the test shaft, and the groundwater in drill holes adjacent to the shaft, 5 ft. from it, and 15 ft. from it. Experience proved that a continuous protective sheath could not be expected to form until (1) the water in the shaft was at 32 deg. F. or below, (2) the temperature of the groundwater in the observation holes adjacent to the shaft had fallen to well below freezing and remained so for some time, and (3) the temperature of the groundwater in the observation holes 5 ft. from the shaft had fallen to near freezing. During the freezing operation, it was observed that as equilibrium was approached, the temperature adjacent to the shaft averaged 22 deg. F., that 5 ft. away averaged 35 deg. F., and that 15 ft. away averaged 45 deg. F. The groundwater temperature was about 55 deg. F.

The effect of the freezing operation inside the shaft was to create a lining of ice about 2 ft. thick on the piling below the surface of the water remaining in it. After unwatering, it was found that the sands and clays on the bottom had been frozen 4 ft. thick from the piling inward; they were so hard that they resisted pavement breakers.

Suggested improvements

Ways of improving the freezing method became apparent during and after the experiment. Time would have been saved, for example, if the freezing pipe assemblies had been equipped with larger sized outer casings than those used, had been spaced closer together and had been located closer to the shaft. Coalescence of frozen materials between the freezing holes would have been more rapid and a reduction would have been effected in the waste incidental to freezing a larger area.

Another improvement would be to change the dimensions of the vertical freezing pipe assemblies themselves, substituting a smaller diameter pipe for the 1-in. intake and a larger diameter pipe for the 2-in. outlet casing. This rearrangement would cause the incoming cold brine to travel with greater velocity and reach the bottom of the freezing pipe more quickly, with a consequent reduction in heat transfer from the warmer outgoing brine to the incoming brine through the pipe. Thus, the incoming brine would be colder when it reached the bottom, and its effectiveness at the lower levels increased.

Installation costs

The freezing process being an incidental experiment within the larger experiment of driving the test shaft itself, the costs are merged with those of the larger project. It is estimated, however, that the driving of the freezing holes, installing the freezing pipe assemblies, installing the ammonia-brine refrigeration plant, fuel, depreciation on equipment and labor totalled about $40,000. The TVA happened to own the refrigeration plant, otherwise it might have rented a plant for the occasion, and the rental charge would have been a little more than the depreciation charges. Operating labor costs were not high, no more than two men being required on day shifts, and only one at night.

Steel sheetpiling was used because a study of its behavior was an integral part of its experiment, but a lining of any kind is unnecessary in sinking a shaft through frozen materials except at the top to protect it against the direct rays of the sun. Thus, the initial cost of lining materials, and the expense of driving and bracing could be dispensed with in figuring costs.

Directing personnel

The construction of Gilbertsville Dam is under the direction of T. B. Parker, chief engineer for TVA; A. L. Pauls, chief construction engineer, and G. P. Jessup, project manager in charge of Gilbertsville project. At the time of the tests, Eugene A. Prokop was acting construction engineer on Gilbertsville Dam. The sinking of the test shaft was recommended and planned by Mr. Prokop, who also supervised the entire sinking operations. He was assisted in the field by B. W. Goodenough.

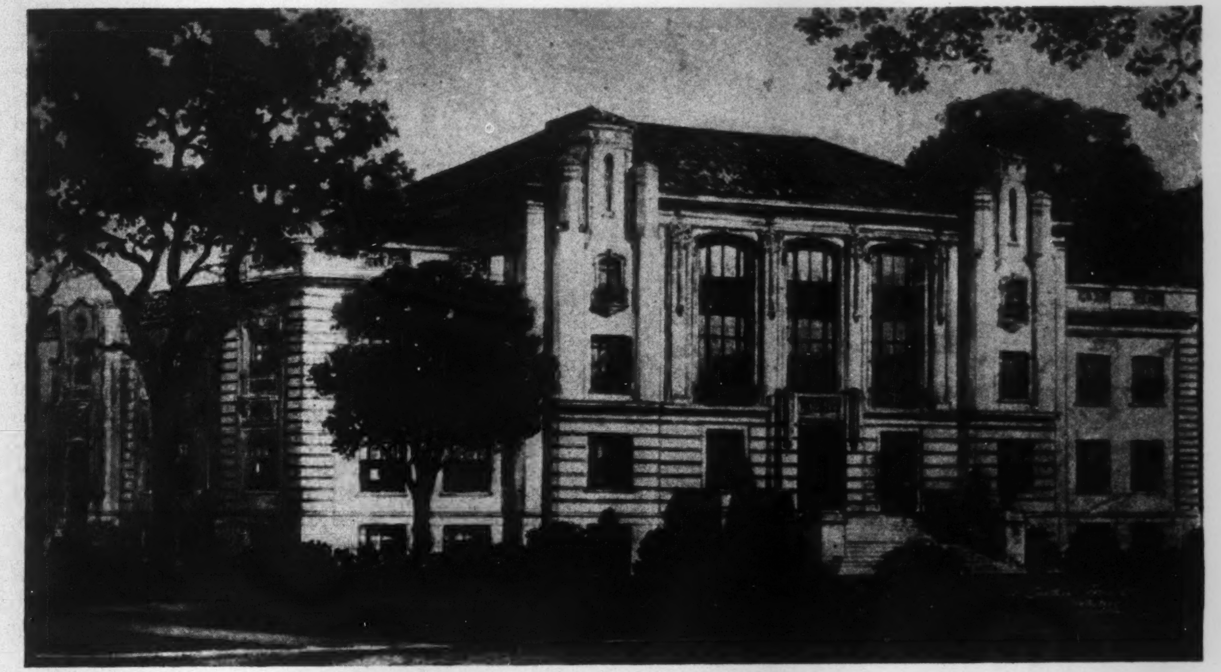


FIG. I. MUNICIPAL UTILITIES BUILDING DESIGNED BY THE CITY ENGINEER'S STAFF.

City Engineering at Its Best

E. J. Cleary

Assistant Editor, Engineering News-Record

***Contents in Brief**—Unusual problems of street and sewer construction at St. Petersburg, Fla., are being met effectively by an efficiently organized and operated public works department. All federal aid work is centered in a separate bureau of that department. Financial problems growing out of the Florida boom are being eliminated and current work is being financed by revenue bonds and federal relief funds.*

Legend has it that the name St. Petersburg chosen for the fourth largest city in Florida was decided on the toss of a coin—it was picked by a Russian engineer who, in company with a Michigan promoter laid out the city a half-century ago. But coin-tossing was limited to the selection of a name only, because present development shows the result of thoughtful public works planning and management. Few cities the size of St. Petersburg—55,000 population—are more capably operated or staffed. Evidence of this can be seen in all the activities of the public works department, which range from airport design to water distribution. Frank O. Lee, director of public works, who came to St. Petersburg from Vermont sixteen years ago, states that municipal engineering practice and problems in Florida contrast with those in Vermont as greatly as do the climate and the topography. Among other things, he cited methods of street construction using only a natural shell base with a light surface treatment; the necessity of laying sewers on flat grades (0.04 per cent on a 48-in. interceptor now going in) and supporting pipe on pile foundations; and the absence of freezing temperatures, which makes it possible to lay water lines close to the ground surface. In one respect, however, recent practice parallels that in most communities—practically all the improvement work is being done by force-account methods with WPA funds. About $2,500,000 of work has been undertaken in this manner, of which the city contributed 24 per cent.

The biggest job underway is a 3½-mile intercepting sewer of 48-in. diameter. This will make possible the abandonment of 29 septic tanks which now inadequately serve about half the city on the north shore of Tampa Bay. The sewer will discharge at an existing disposal plant where fine screening and chlorinating facilities are provided. The plant has a capacity of 20 m.g.d.—more than twice the present requirements.

But there is need for extra plant capacity aside from rapid growth demands. Even the best sewers in the sand soils of Florida are subject to unusual groundwater infiltration. Since this land along the coast is only a few feet above water most of the sewers are submerged in or close to the groundwater zone. Consequent-

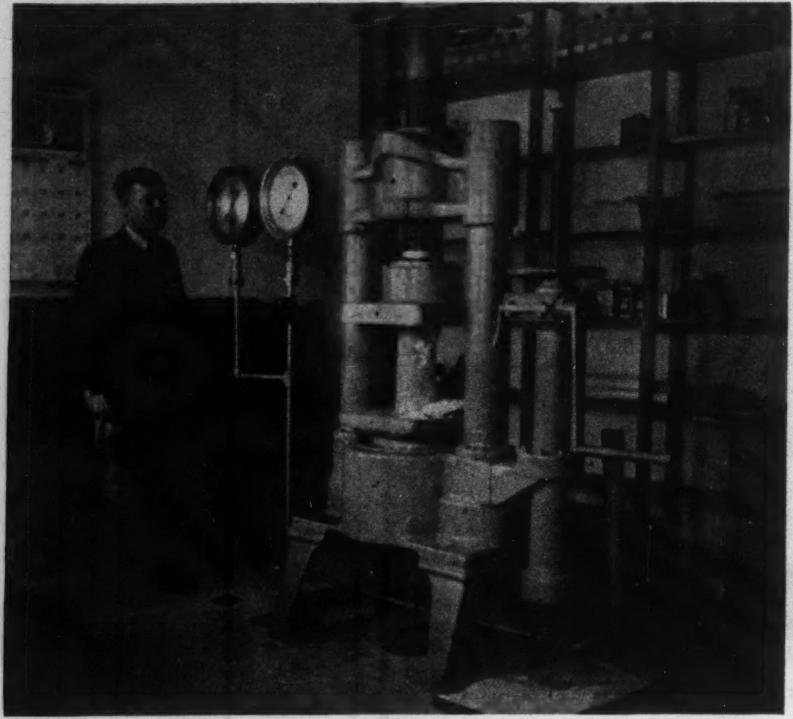


Fig. 2 Material testing laboratory operated by the public works department to insure high quality road and concrete construction.

ly, during periods of rainfall considerable leakage occurs, all of which must be pumped at the disposal plant. In February, 1937, for instance, when the rainfall was 11 in., the plant flow was 39 per cent greater than water consumption.

The saturated sandy soil also adds to construction difficulties. Not only must trenches be carefully sheeted and dried with well points, but the pipe must be laid on 3x10-in. plank foundations. And in many places wood piles (about 8 ft. in length) are driven at 6-ft. intervals to support the planks before the sewer is laid. Vitrified clay pipe is used in sizes up to 24 in.; concrete pipe is employed for the larger sizes.

A bird's-eye view

When the writer asked for information on the general layout of the city, Mr. Lee proved to be as up-to-date in his manner of showing this as he is in his methods of public works administration. He reached for the telephone and requested the municipal airport manager to have a plane ready for flight in five minutes. The airport, which is one of St. Petersburg's finest civic improvements, is only a few minutes' walking distance from the center of the city. There was hardly time to make camera adjustments before we were up in the air.

Major points of interest as seen from the air were the million dollar recreation pier (*ENR*, July 4, 1935, p. 1), the many wide, paved thoroughfares which criss-cross the city, and the vast amount of subdivided vacant land. The subdivisions, most of them paved and serviced with utilities, are a grim reminder of the Florida land boom of 1923-26. Within the 56 square miles embraced by the city limits, it is estimated that 70 per cent of the area is unoccupied, subdivided land. A further idea of how much land development took place is obtained from the fact that there are 1,200 miles of streets in this city of only 55,000 population!

To the early developers of the city, credit must be given for unusual foresight in establishing wide streets, a practice which has since been closely adhered to. All the principal arteries of travel are 60 ft. from curb to curb. Residential streets are laid out to a 27-ft. roadway. Of the 335 miles of paved streets, the predominant surface is brick—some 162 miles being treated this way. About 77 miles are of asphalt block, and the remainder are of surface-treated shell construction. The latter is peculiar to Florida, and is a development which shows how local materials have been

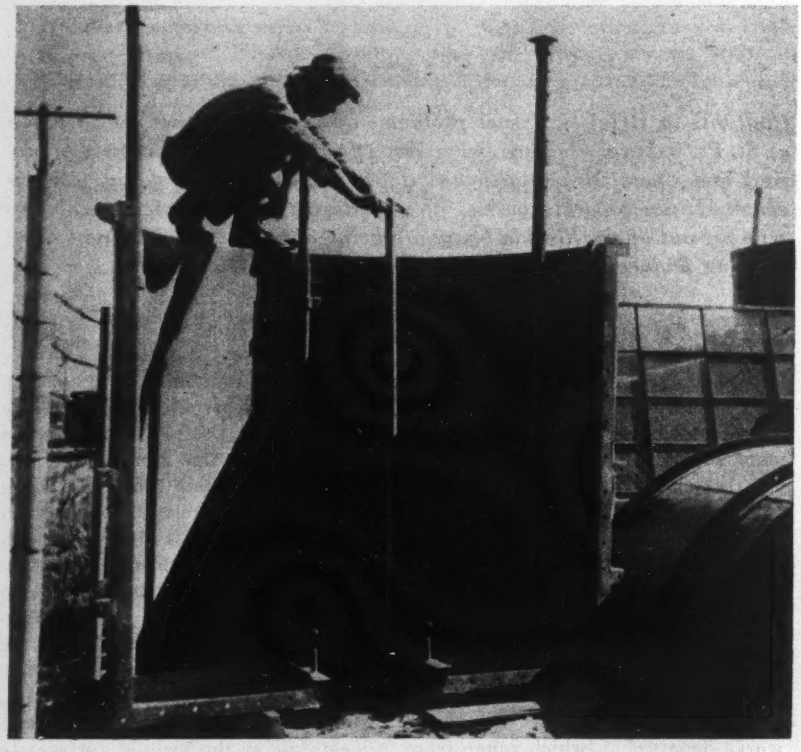


Fig. 3. Repair of concrete piles under water is made possible by this portable steel caisson recently developed by the city. The two halves form a cylindrical chamber which can be dewatered after it is bolted around the pile.

successfully adapted to meet local needs economically.

Oyster shell for roads

This is how St. Petersburg builds a surface-treated street: The section to be paved is excavated to a depth of about 6 in. and is refilled with a mixture of shell and clay—a material which is dredged from the shallow sea bottom of the adjacent coast—consisting mostly of oyster shells. This material is rolled and scarified many times until the shell becomes broken into small pieces and a homogeneous mixture of shell and clay is obtained. While being "worked" the mixture is kept moist. Finally, this base material is compressed with a roller and permitted to dry. Free lime liberated from the shell forms a cement, and the base becomes quite dense and hard. The base is then sprayed with a tar prime coat at the rate of 0.2 gallons per square yard, and is opened to traffic for two or three weeks.

A wearing surface is then applied. This may be of two types, depending on the traffic to be borne. On light-traffic residential streets a single surface treatment is used. This consists of emulsified asphalt (0.5 gal. per sq.yd.) over which is spread 35 to 40 lb. per sq.yd. of crushed rock. For heavier traffic needs, a double surface treatment is used. It consists of two successive applications of 0.35 gal. of asphalt and 25 lb. of crushed stone per sq.yd. Surfaced shell-base streets cost 65 and 80c. per square yard, depending on the number of surface treatments.

Incidentally, traprock from the Hudson River valley in New York is preferred for surfacing. This basaltic rock in the ½-in. size produces a tough non-skid surface. The rock comes by boat, frequently as ballast. When it is not available, Florida limestone or crushed slag is used.

Financial reverses

St. Petersburg clearly admits that without federal funds, public works improvements which are sorely needed would have been long deferred. Financially the city is laboring under the impact of two severe blows. The first came in 1926 when the Florida boom collapsed leaving the city with an enormous debt incurred by issuing bonds for the extension of services. Then came the demoralizing depression of 1929. As a result, the city defaulted on its bonds of 1930, and only through the issuance of scrip was it possible to operate.

But the financial picture is not so gloomy now, said T. L. Crossland, director of finance. And he showed the writer a graph which depicted changing conditions; in 1933 the city was able to collect only 48 per cent of its taxes; in 1934 it got 63 per cent; and each year thereafter collections have been increasing until now more than 85 per cent is being obtained. Furthermore, delinquent tax collections have been good so that only about 10 per cent are outstanding. In addition, a general bond refunding program has been completed by which the city has made a substantial reduction in its interest payments.

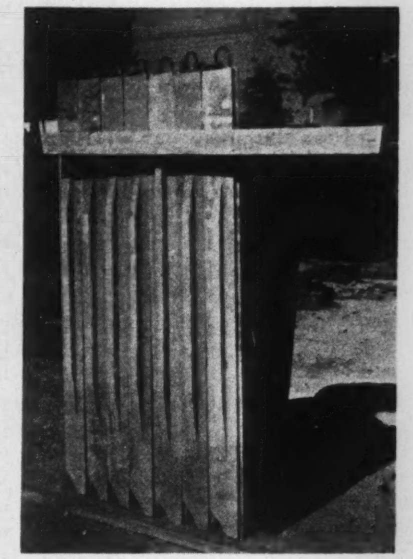


Fig. 4. Model of the precast concrete seawall which is now under construction.

The only way in which money can be raised now for capital expenditures, said Mr. Crossland, is by means of revenue bonds. This method has been used to finance a PWA loan and grant for a $400,000 municipal utility building now under construction (Fig. 1). The cost of this structure, which is of reinforced concrete construction, will be liquidated by revenue obtained from the income of the municipal gas plant.

A word on organization

The public works department in St. Petersburg is efficiently organized on a line and staff basis. It includes seven line or operating bureaus, each headed by a superintendent or manager, and two staff or functional bureaus. The latter include an engineering design and construction bureau which is under the direction of the assistant city engineer, and a bureau of records, costs and inspection. All bureau heads report to the director of public works, who also acts as city engineer.

Of particular interest in this organization is the establishment of a bureau of federal projects. Here are centered all relations between the public works department, the WPA and PWA. The bureau serves as a clearing house and coordinating unit to handle labor assignments, material requisitions and other details involved in the conduct of business with the federal government and local works relief agencies.

Waterfront activities

Among present activities of special interest are the new seawall, and the reconstruction of disintegrated concrete piles using a novel portable caisson. The latter was developed by Paul Jorgensen, assistant city engineer, so that piles could be repaired at the water line. It consists of a 6-ft. steel cylinder shell (Fig. 3), with a special rubber-gasketed opening that can be tightly fitted around the square pile. The cylinder is of split construction so that the two halves can be placed around the pile, bolted closed and then dewatered. Thus it is possible to work on a pile in the dry regardless of tide elevations. The caisson cylinder is floated into position resting on two rowboats, and it is easily moved from place to place.

The concrete seawall likewise introduces some new ideas in waterfront construction methods (Fig. 4). The piles are of thin slab design, with a T-section at the area where the greatest moment occurs due to earth pressure backfill. The piles, varying in length from 20 to 30 ft., are precast, and provided with a tongue-and-groove joint. Insurance against leakage of sand between joints will be secured by sliding a 2x8-in. plank against the inside face of the joint. A depressed groove in the slab pile has been provided to keep the plank securely centered over the joint. (Both the seawall design and that of the pile caisson will be described in more detail in subsequent articles).

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

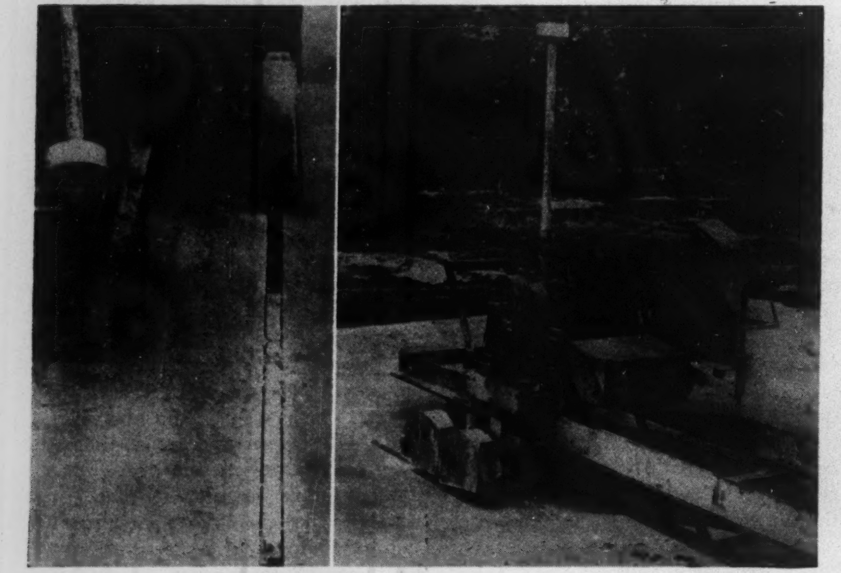
Paving Joint Cutter

Expansion joint filler in concrete pavement is usually left at least 1½ in. below the finished surface with a board or metal strip placed over the top of the premolded or air cushion joint. The finishing machine passes over the joint and two men follow to clean off the top of the board and to finish the surface of the concrete with an edging tool. Later the board is removed and the space that it occupied is filled with asphalt. The tool marks left at the edge of the slab are likely to cause a slight irregularity in the surface noticeable to the motorist.

Engineers of the University of Illinois civil engineering department have developed a method to remove the bump at the joint. The board or strip is omitted and the concrete is finished over the joint to be cut out later with a power-saw machine carrying two thin parallel abrasive wheels. A clean square cut results which eliminates the irregularity of the hand-finished joint. Several of the new-type joints have been placed on Route 1 north of Danville, Ill.

The machine illustrated costs about $460 but probably could be duplicated in quantity at $275 to $350. The abrasive wheels cost about $2.50 each and last one day on the average. Investigation is being conducted to secure a wheel of longer life. In limestone aggregate a joint 11 ft. long can be cut in about 45 min. Cuts ¼ to 3/16 in. deep are made at each traverse, the operation being repeated until the necessary depth has been reached. The cut section is pried out in short pieces. Two operators do the job.

The experimental work was carried out under the direction of J. S. Crandell, professor of highway engineering, University of Illinois, with the assistance of W. A. Grasso and E. S. Fraser.



A T-beam frame provides a track for the pavement joint cutter (right) consisting of two abrasive wheels. The concrete, between cuts (left) down to the expansion joint material, is pried out and the space is filled with a plastic material.

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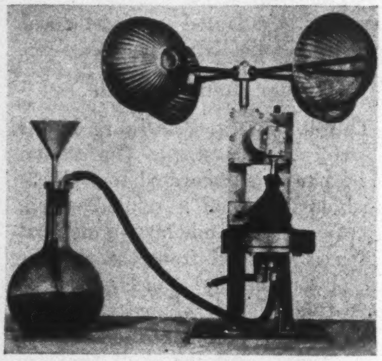
An Automatic Air Sampler



Wind-driven device that automatically takes air samples for laboratory analysis.

An instrument that automatically takes samples of air to be analyzed in the laboratory for corrosive content, recently developed by the California Division of Highays, has been used in studies of the protection afforded by paints against fumes from refineries, etc. The device was made to meet the need for obtaining air samples over a long period of time at minimum expense. The instrument is automatic, is operated by wind power, can be set in any location and can be left for long periods without attention other than occasional reading of the revolution counter and changing the bottle containing distilled water and absorbed impurities. The wind motor, which will operate on a 4-m.p.h. wind, was preferred to a spring drive because of greater simplicity. For taking samples where there is no air movement, the pump and motor can be set in a more exposed location and an extension tube carried to the water bottle.

The shaft rotated by the wind cups terminates in a worm meshing another worm within a gearbox kept partly filled with oil. The shaft on this second worm, which is horizontal, carries a revolution counter on one end while the opposite end drives a connecting rod operating a rubber diaphragm pump. The diaphragm is protected from moisture and dirt by a canvas covering tied around the connecting rod. The intake valve on the pump connects with a rubber tube drawing air from a bottle partly filled with distilled water. The arrangement is such that air drawn from the water bottle is replaced by incoming air that has to pass through the water, thus leaving in the water all solids and soluble gases. As each stroke of the pump draws 61 milliliters out of the water bottle, the revolution counter reading gives the quantitative factor for chemical analysis made in the laboratory.

The device was designed by

(Continued on p. 82)

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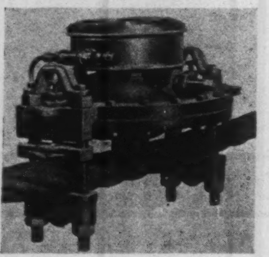

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(Continued from p. 80)

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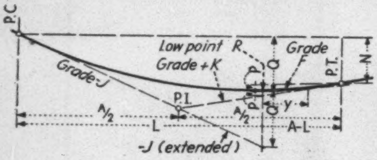
• • •

Simplified Formulas For Vertical Parabolic Curve

Myer Ableman
Associate Highway Engineer,
State Highway Department,
Jefferson City, Mo.

There are a number of different formulas for finding the low (or high) point of a vertical parabolic curve. The writer offers the following simplified formula that can be used in every-day practice. This solution is based on the well-known theory that the external between the P.I. and the curve equals the middle ordinate between the curve and the chord from P.C. to P.I. In solving for low point R (Fig. 1)



$$N = \left(\frac{A}{2} \times J\right) - \left(\frac{A}{2} \times K\right)$$

$$= A \quad \frac{J - K}{2} \quad = \frac{AJ}{2} - \frac{AK}{2}$$

$$2P = (A - L)K \quad P = \frac{AK - LK}{2}$$

$$2Q = LJ \quad Q = \frac{LJ}{2}$$

$$Q = N + P$$

$$\text{Therefore } \frac{LJ}{2} = \left(\frac{AJ}{2} - \frac{AK}{2}\right)$$

$$+ \left(\frac{AK}{2} - \frac{LK}{2}\right)$$

$$LJ + LK = AJ$$

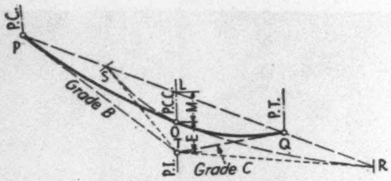
$$L = \frac{AJ}{J + K} \text{ or } L$$

$$= \frac{\textit{Length of Curve times Adjacent Grade}}{\textit{Sum of the two grades}}$$

To find grade F any distance y from R, use the above formula:

$L = \frac{(L + y)\,J}{J + F}$ in which $(L + y)$ is substituted for A (length of curve)

$$J + F = \frac{LJ}{L} + \frac{yJ}{L}$$



$$F = J - J + \frac{yJ}{L} \qquad F = \frac{y}{L}J$$

This proves that tangent grades on a parabolic curve are directly proportional to the distance from the low point.

In Fig. 2, the curve POQ is a compound parabolic curve having a P.C.C. at O which is at the same station as P.I. If the chord from P.C. to P.I. is drawn, TO equals OL or E equals M. Then to find the external E, all that is necessary is to divide distance TL by 2. With the external distance known, the tangent offsets to each curve can be worked independently.

To prove that E equals M in this figure, continue line PQ to R so that TR equals TP. Referring to the theory that externals equal middle ordinates on curves where tangents are equal, for parabolic curve POR which fits this case, E equals M. Now draw line TS equal to TQ. Then for parabolic curve SOQ, E equals M. As POR and SOQ are tangent at O, half of each curve comprises a compound curve, each has the same external distance E which is equal to one-half of distance TL.

FIELD & OFFICE COMMENT

Where the Decimal Goes

Sir: Referring to the article (*ENR*, March 16, 1939, p. 62) by John B. Douglass of Charleston, W. Va., on "Where the Decimal Point Goes": His rule is of course correct, but it has to be memorized. In order that this rule shall ever be before me, I move the slide to the right and near the end on the wood thus exposed, I put the following sign in white ink:

× Sum + 1
÷ Difference + 1

Then, moving the slide until it extends to the left, I put this sign

× Sum
÷ Difference

In this way the proper rule to use is always exposed.

Troy Carmichael
President, Standard Bitulithic Co.
New York, N. Y.

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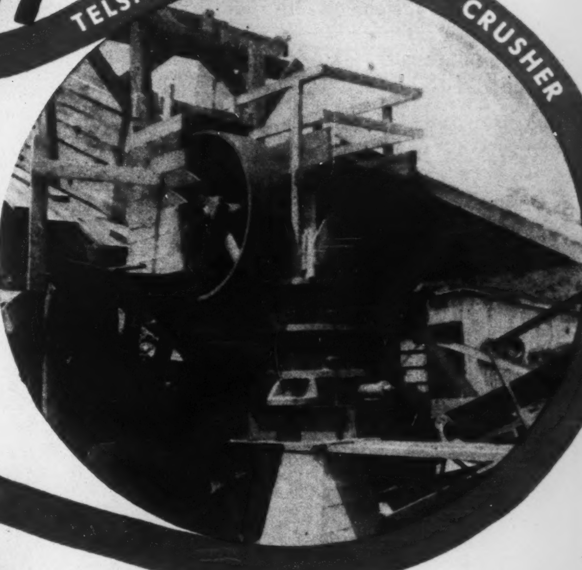
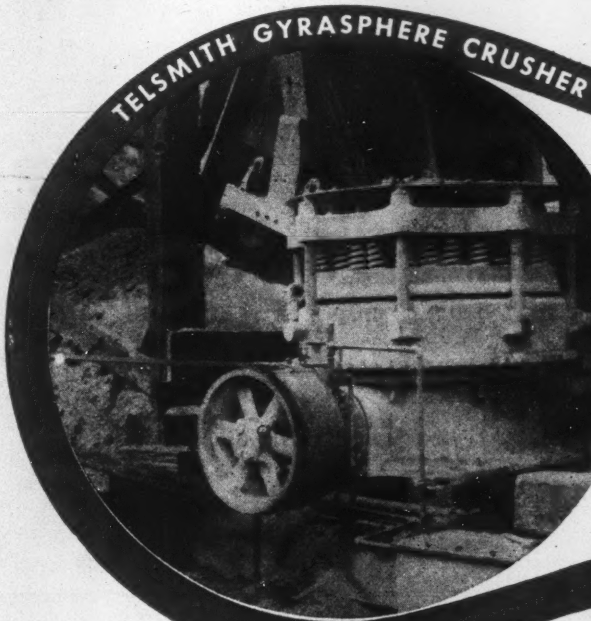


The most modern type of jaw crusher . . . for coarse or intermediate crushing . . . the Telsmith-Wheeling is equipped throughout with *cylindrical roller bearings.* This crusher delivers more crushing strokes per minute . . . almost double capacity . . . and greater reduction in one process than with any other type of breaker. All internal frictional wear is taken on the bearing races . . . no wear on shaft. Up-keep is reduced . . . service life prolonged. 7 sizes. *Write* for Bulletin W-2.

TELSMITH GYRASPHERE CRUSHER



EXTRA PROFITS

For secondary crushing, the Telsmith Gyrasphere takes an unlimited choke feed . . . crushes finer with fewer over-size slabs and splinters . . . costs less for power and upkeep. With its spherical crushing head, impelled by both the gyrated shaft and the rotary wedge action of the supporting eccentric, its crushing action is the most effective ever devised. *Write* for Bulletin Y-2.

TELSMITH PULSATOR

LOWER UP-KEEP

Sand, gravel, crushed rock, ore, coal—Telsmith Pulsator *screens 'em all,* wet or dry, and does it *right.* Its circular movement produces a maximum screening action that's *uniform* on every inch of the wire, regardless of load. Telsmith builds in greater value, longer life and lower up-keep with the toughest alloy steels, anti-friction bearings, and special seal protection for working parts. 11 sizes . . . 1, 2, 3 and 4 decks. *Write* for Bulletin V-2.

SMITH ENGINEERING WORKS
500 E. CAPITOL DRIVE, MILWAUKEE, WISCONSIN
Cable Addresses: Sengworks, Milwaukee. Concrete, London
Associates in Canada: Canadian Vickers, Limited, Montreal, Vancouver

50 Church Street
New York City

211 W. Wacker Drive
Chicago, Ill.

713 Commercial Trust Building
Philadelphia, Pa.

81 Binney Street
Cambridge, Mass.

412 Westinghouse Bldg.
Pittsburgh, Pa.

Brandeis M. & S. Co.
Louisville, Ky.

MC 10-A-39

TELSMITH

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

MAY construction material prices areslightly more active than last month, with lumber prices providing the most important change. Short Leaf Yellow Pine is up 50c. to $1.00 in Atlanta and up $2.00 to $5.00 in Detroit on all sizes, but off 50c. per M ft. in St. Louis. Roofers North Carolina Pine is down $2.00 in Boston on the 1-in. sizes. Douglas Fir is $2.00 lower on the 2x10-in. and 1-in. sizes at Boston; $1.00 lower on most 2-in. sizes in Chicago, and on 1-in. sizes in Montreal. Douglas Fir timbers are $3.00 higher in Detroit, but $1.00 lower in Seattle.

Cement is 15c. per bbl. lower, and sand and gravel is off 17c. per ton in Seattle. Ready-mixed concrete is 20c. lower in Dallas, 50c. lower in Minneapolis, and 5c. lower in Seattle.

Paving asphalt is down 50c. per ton in Detroit, but up $3.00 in St. Louis.

Structural steel shapes are 6c. per cwt. lower in Kansas City, 35c. lower in St. Louis, and 40c. lower in San Francisco. All other steel prices remain at their April levels.

The Atlanta structural ironworkers' rate is up 12½c. from the former $1.25 per hr. rate. Hoisting engineers' new rate in Los Angeles, $1.125, is 25c. per hour lower. Plasterers' rate in Denver, $1.50 per hr. is an increase of 7c.

Common labor rates in Detroit which formerly ranged from 60 to 80c., now range from 60 to 75c.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE
	Cloth Bags *a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Ready Mixed 1:2:4, 50 c.y. or more, delivered
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.75
Baltimore	2.31	2.06	1.91	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.75
Birmingham	2.55	2.30	1.99	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75*b*	2.50*b*	2.30	1.10	1.10	.80	1.10	1.10	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.47	2.22	2.07	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.65*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.05	1.15	.80	1.45	1.45	1.50‡	1.50‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.10	1.10	1.10	1.10*f*	1.10*f*	....	....	6.35
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	....	1.58	....	....	1.25‡	.90‡*c*	1.00‡*c*	....	....	7.60*l*
New Orleans	2.41	2.16	....	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.50
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

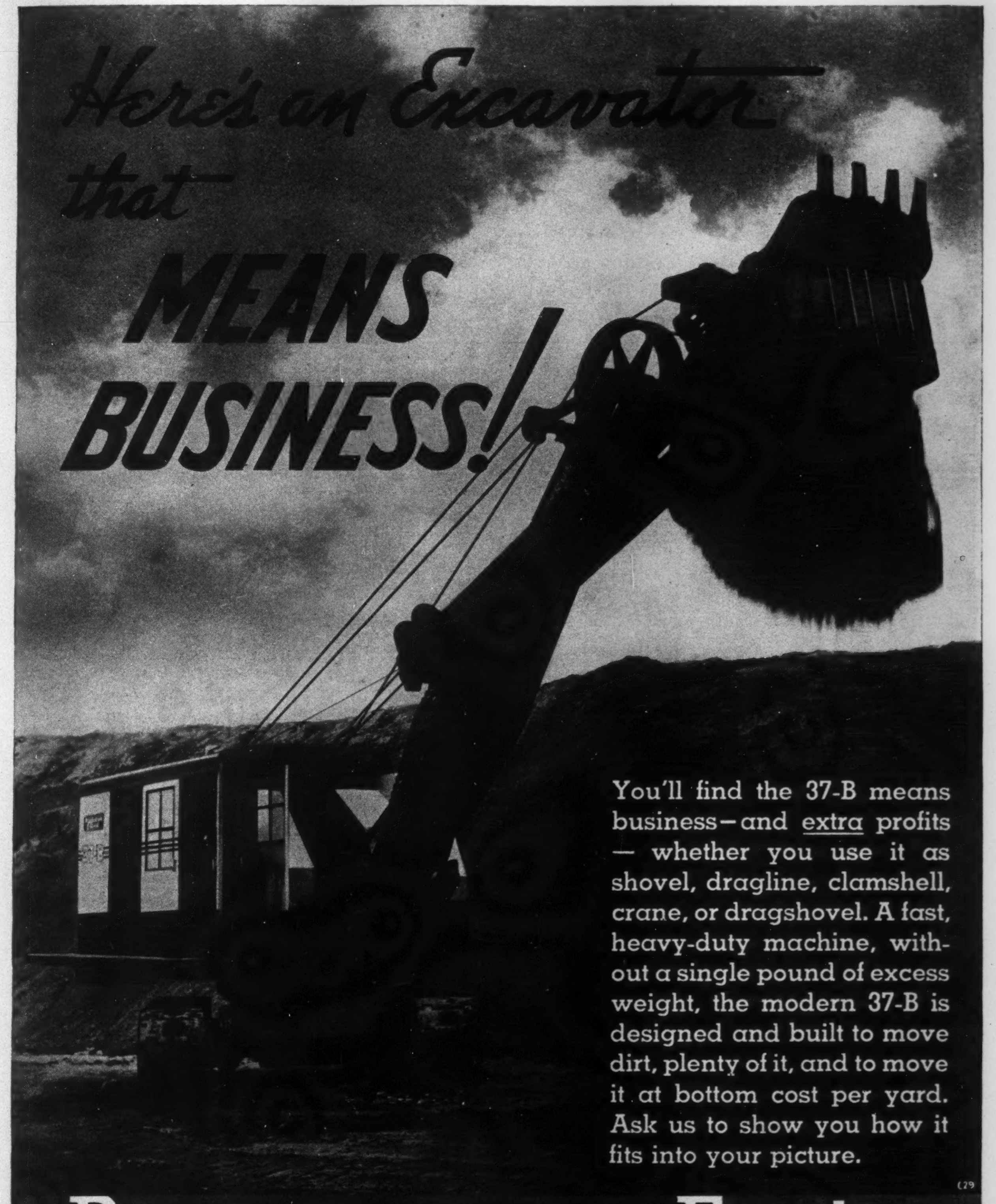
	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65			

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT Per ton, less than 80 penetration		ASPHALT BINDERS — FLUXES Per gal. 80–300 penetration		CUTBACK ASPHALT Per ton		ROAD OILS Per gal.	ASPHALT EMULSION (Quick-breaking) Per gal.	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60*e*	$21.80*e*	$0.0675*e*	$0.0968*e*	$0.0734*he*	$0.1053*he*	$0.0583*e*	$0.0834	$0.0834
Baltimore	140.00‡	44.00‡	2.50	13.00	18.00	.05	.08	.06*h*	.09	......	......	.....
Birmingham	......	25.00	......	18.20	23.40	.0747	.1047	.0834*h*	.1134*h*	......	......	.....
Boston	80.00	46.50	3.00	13.00	19.00	.05	.08	.06*h*	.09*h*	......	.09‡	.12‡
Chicago	140.00	52.00	2.60	14.00	18.00	13.00*g*	17.00*g*	.06*h*	.11*h*	.03	.08	.12
Cincinnati	112.00	37.50	......	14.31	18.31	.10	......	18.00	......	.0525	.....	.08
Cleveland	110.00	37.25	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.05	.08	.09
Dallas	......	30.50	......	12.00	17.00	.04	.07	13.00	18.00	.035	.05/.07	.07/.09
Denver	......	27.50	......	......	......	......	......	......	......	......	......	.....
Detroit	......	35.00	......	13.60*f*	19.50*f*	14.00*g*	18.40*g*	14.00	19.70	.0535	.066	.0995
Kansas City	......	44.00	......	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	......	50.00	......	6.50*b*	15.00	6.50*b*	15.00*g*	5.50*b*	......	.0192	.0525	.1125
Minneapolis	......	......	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	......	.....
Montreal	82.50	......	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.0935	.13	.16
New Orleans	......	......	......	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	......	.078	.....
New York	......	68.00	2.80	13.50	18.50	.055	.08	.06*h*	.09*h*	......	.07	.10
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	115.00	40.00	......	......	......	......	......	......	......	......	......	.....
St. Louis	110.00/121.00	37.00	......	15.00	20.00	.055	.085	.06*h*	.09*h*	.04	.08	.12
San Francisco	......	70.00	......	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	......	60.00*c*	......	13.90	22.90	......	24.50*g*	9.15/10.50	23.00/24.00	7.75*g*	.0575	.1308

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon.

(*Continued on page* 86)



You'll find the 37-B means business—and extra profits — whether you use it as shovel, dragline, clamshell, crane, or dragshovel. A fast, heavy-duty machine, without a single pound of excess weight, the modern 37-B is designed and built to move dirt, plenty of it, and to move it at bottom cost per yard. Ask us to show you how it fits into your picture.

C29

Bucyrus · Erie

SOUTH MILWAUKEE, WISCONSIN

(Continued from page 84)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ½-in. billet *b*	RIVETS ¾-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.05	$3.40	$2.45	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.05	3.40	2.45	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.05	3.40	2.45	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.05	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.05	3.40	2.45	....	....	....	....	....	....	....	....
Youngstown	....	2.05	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.15‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.40*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.70*a*	2.50*a*	....	....	2.90*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* For rail steel deduct 15c. from billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ½ in., base price 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.74	$2.29	$2.14	.02½	.10	$21.00	$23.00	$1.66	$1.25	$0.1566	$3.04
Baltimore	3.55	2.70	2.55	......	.10	21.00	23.00	1.54	1.17	.1458	2.70
Birmingham	2.10*a*	2.05	1.90	.02½	.10	19.50	21.50	1.64	1.23	.1548	....
Boston	3.85	2.58	2.43	$20 C.L.	.10	21.50‡	23.50‡	1.60	1.21	.1512	2.99
Chicago	2.10*a*	2.05	1.90	.03	.05	18.50	20.50	1.51	1.15	.1422	2.40
Cincinnati	3.88	2.31*c*	2.16*c*	......	.05	20.50	22.50	1.50	1.14	.1413	....
Cleveland	3.43*g*	2.05	1.90	.02½	.10	20.50	22.50	1.50	1.14	.1422	....
Dallas	4.15	2.80	2.65	......	.....	25.00	27.00	1.77	1.32	.1674	....
Denver	4.21	3.89	3.74	......	......	23.50	25.50	1.81	1.34	.1710	....
Detroit	3.80‡	2.55	2.40	......	.10	22.50	24.50	1.52	1.16	.1440	2.875
Kansas City	4.04	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.62	1.22	.1539	2.86
Los Angeles	3.50*f*	2.65	2.50	.02½	.05	23.00	27.50	1.77	1.32	.1674	3.50
Minneapolis	3.80‡	2.38*c*	2.23*c*	.0	.10	21.50	24.50	1.64	1.23	.1548	2.73*d*
Montreal	3.25	2.65	2.55	......	......	26.68	29.90	2.90	2.00	.300	3.95
New Orleans	3.90	2.69	2.54	.05	.10	21.00	23.00	1.67	1.26	.1584	2.875
New York	3.75	2.29	2.14	......	.10	20.50	22.50	1.56	1.19	.1476	2.76
Philadelphia	3.40	2.37	2.22	......	......	20.50	22.50	1.55	1.18	.1467	2.72
Pittsburgh	2.10*a*	2.05	1.90	.02½	.10	21.50	24.50	1.43	1.10	.1350	2.40
St. Louis	3.47	2.29	2.14	.0	.05	23.50	25.50	1.53	1.16	.1449	2.70
San Francisco	3.50	2.50	2.35	.02½	.10	23.50	25.50	1.77	1.32	.1674	3.00
Seattle	2.70*e*	2.65*e*	......	......	......	25.50	27.50	1.77	1.32	.1674	2.90*e*

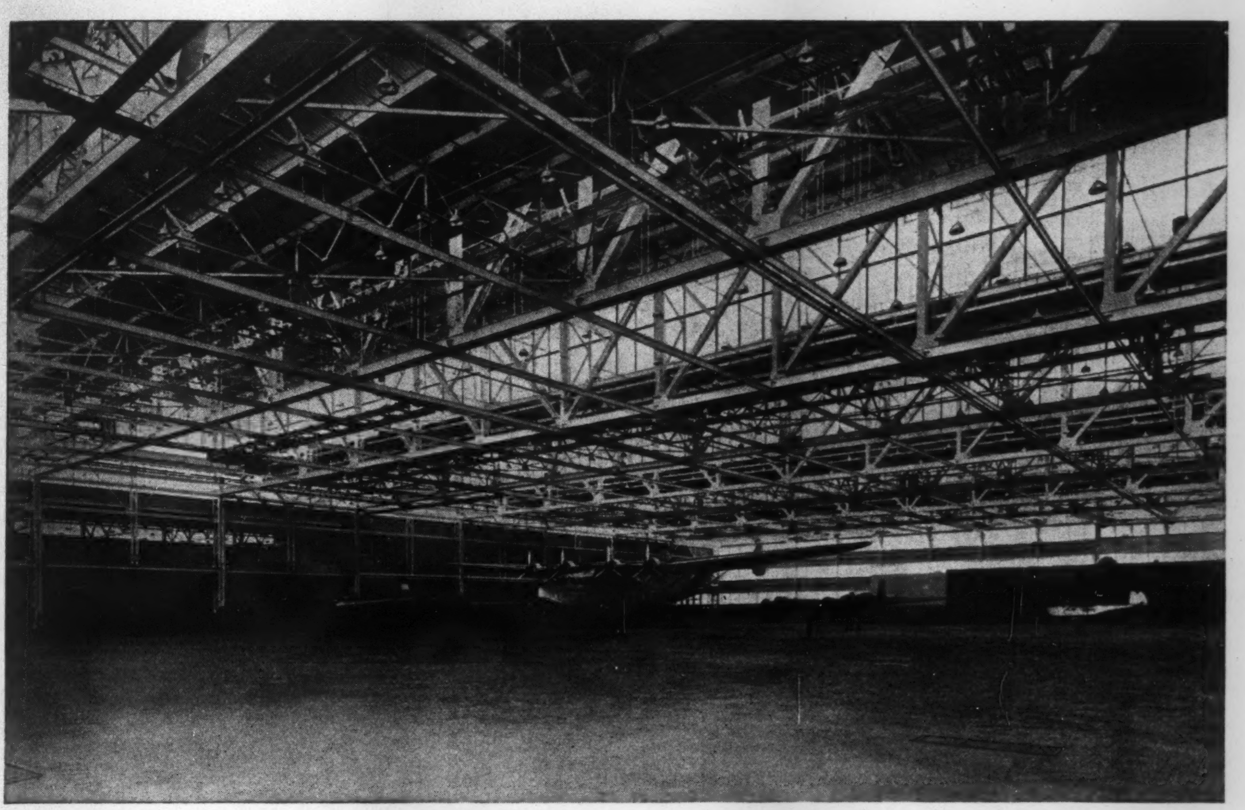
‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in. *a*	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$46.40	$0.26*bc*	$0.468*bc*	$1.69	$4.50*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	49.80	.30	.55	2.40	6.25	110.00	170.00	.50	1.75	65.5	57.5	63.0	54.5
Birmingham	42.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	52.00	.245	.4725	1.98	5.535	166.50‡	240.00‡	.45	2.30	64.1	56.1	61.6	53.1
Chicago	50.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	49.70	.231	.4455	1.755	5.2275	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	51.24	.21	.405	1.575	4.8175	69.00	108.00	.34	1.45	67.8	59.8	65.3	56.8
Dallas	55.20	.27	.486	1.944	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	57.60	.29†	.50†	2.10†	......	130.00	220.00	......	......	58.4	50.4	55.7	47.2
Detroit	51.24	.147	.2835	1.215	4.70	66.45	111.40	.25	1.125	66.3	58.3	63.8	55.3
Kansas City	52.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	52.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	54.20	.24†	.432†	1.728†	4.60†	......	......	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.59	.90	3.15	5.10*e*	135.00‡	260.00‡	.48	1.92	......	......	......	......
New Orleans	48.38	.26	.48	1.69	......	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	49.20	.32	.63	2.35	6.15	......	......	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	47.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	52.60	.182†	.351†	1.44†	4.20	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	49.48	.28	.504	2.016	3.96	80.00	170.00	.80	2.00	65.1	57.1	62.0	53.5
San Francisco	52.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	......	......	......	......
Seattle	52.35	.35	.63	2.52	6.30	72.00	175.00	.50*f*	1.40*f*	......	......	......	......

‡ Delivered. † F.o b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $46.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20.

(Continued on page 88)



BROAD-RANGE EXPERIENCE

that solves construction problems

THE activities of Bethlehem's steel construction division range from the fabrication and erection of standpipes and factory buildings to the Golden Gate Bridge and lock gates for the Panama Canal. Again and again this broad-range experience has enabled Bethlehem to solve unusual problems of construction with maximum speed and economy.

At Glenn L. Martin Company's Baltimore plant a program for the building of ocean-going seaplanes—Martin Ocean Transports—called for the world's largest aircraft assembly floor. Doing without interior columns in a structure with ground dimensions of 308 x 453 feet presented a nice problem of roof construction which the engineers, Albert Kahn, Inc., solved by use of parallel chord trusses. Bethlehem's broad range of experience provided a useful background both in the development of practical details in the design of these members, which are 303 feet long and adapted from bridge design, and in handling special problems incidental to fabricating and erecting them.

Comprehensive experience is one of the assets Bethlehem brings to every type of steel construction; unusual facilities are another. Both the construction and steel-making divisions are closely coordinated. Fabricating shops and depots of erection equipment maintained at key locations throughout the country are a further advantage.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

(Continued from page 86)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10, S4S	3x12, Rgh	6x12, Rgh	12x12, Rgh	2x12, Rgh	12x12, Rgh	⅝"	¾"
Atlanta	**$20.00**	**$20.00**	**$20.00**	**$21.00**	**$21.00**	**$21.00**	**$28.00**	......	......	$38.50	$50.50	$17.75	$21.60
Baltimore	**24.00**	**25.00**	**24.00**	**25.00**	**26.00**	**27.00**	**39.00**	......	......	68.00	70.00	17.35g	21.15g
	31.00	*31.00*	*31.00*	*31.00*	*31.00*	*31.00*	*39.00*	*$39.00*	*$39.00*	......	......	......	......
Birmingham	**19.00**	**19.00**	**19.00**	**19.00**	**19.00**	**20.00**	**30.00**	**30.00**	**30.00**	......	......	16.25	19.85
[1]	22.00	22.00	26.00	26.00	26.00	36.00	54.00	......	......	48.00	53.00	......	......
Boston	26.00[2]	26.00[2]	30.00[3]	30.00	48.00[1]	58.00[1]	72.00[1]	......	......	72.00	72.00	17.35g	21.15g
	24.00	*24.00*	*28.00*	*30.00*	*32.00*	*32.00*	*35.00*	*40.00*	*40.00*	......	......	......	......
Chicago	**29.00**	**30.00**	**32.00**	**30.00**	**32.00**	**31.00**	**47.00**	......	......	75.00	85.00	13.15	16.05
	33.00	*34.00*	*35.00*	*34.00*	*34.00*	*36.00*	*41.00*	*40.00*	*40.00*	......	......	......	......
Cincinnati	**23.75**	**23.75**	**25.00**	**23.50**	**24.50**	**26.50**	**37.50**	......	......	46.00	49.00	16.25	19.85
	......	......	......	......	......	......	*39.50*	*39.50*	*39.50*	......	......	......	......
Cleveland *f*	**30.00**	**31.00**	**36.00**	**31.00**	**32.00**	**40.00**	**48.00**	......	......	52.00	62.00[8]	16.65	20.25
Dallas *e*	**28.50**	**31.50**	**30.00**	**26.00**	**28.50**	**31.50**	**55.00**	**54.00**	**54.00**	64.50	71.00	13.90	16.95
Denver ‡	41.00[4]	39.00[4]	43.00[4]	42.00[4]	42.00[4]	47.00[4]	45.00[4]	56.00[4]	64.50[4]	......	......	9.90	12.05
Detroit	**26.00**	**26.00**	**27.00**	**27.00**	**29.00**	**31.00**	**36.00**	......	......	31.00	43.00	16.25	19.85
	......	......	......	*36.00*	*36.00*	*36.00*	*37.00*	*43.00*	*43.00*	......	......	......	......
Kansas City	**27.00**	**28.50**	**28.00**	**26.00**	**28.00**	**30.00**	**35.00**	......	......	55.00	58.00	12.25	14.95
	28.00	*28.00*	*28.00*	*28.00*	*28.00*	*29.00*	*34.00*	*35.00*	*35.00*	......	......	......	......
Los Angeles *a*	*35.00*	*35.00*	*35.00*	*35.00*	*36.00*	*36.00*	*42.00*	*46.00*	*42.00*	......	......	9.35gh	11.35gh
Minneapolis ‡*b*	43.00[5]	43.00[6]	......	......	......	......	......	......	......	......	......	12.05	14.70
‡	*34.00*	*34.00*	*35.00*	*35.00*	*35.00*	*35.00*	*55.00*	*55.00*	*55.00*	......	......	......	......
Montreal [7]	*44.00*	*44.00*	*49.00*	*47.00*	48.00	58.00	84.00	......	......	135.00	145.00	......	......
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.00*	*41.00*	*40.50*	*40.00*	......	......	......	......
New Orleans	**22.00**	**22.00**	**20.00**	**19.00**	**20.00**	**22.00**	**42.00**	......	......	58.00	65.00	13.90	16.95
	26.00	*26.00*	*28.00*	*29.00*	*32.00*	*30.00*	*32.00*	......	......	......	......	......	......
New York ‡	**36.00**	**37.00**	**35.00**	**36.00**	**36.00**	**37.00**	**42.00**	......	......	77.50	80.00	17.35g	21.15g
‡	......	......	*40.00*	*40.00*	*40.00*	*40.00*	*40.00*	*42.50*	*42.50*	......	......	......	......
Philadelphia	**23.50**	**24.00**	**25.00**	**25.00**	**26.00**	**26.50**	**28.50**	......	......	54.00	56.00	17.35g	21.15g
	34.00	*35.50*	*38.00*	*37.25*	*36.50*	*36.50*	*41.75*	*31.50*	*31.50*	......	......	......	......
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	......	......	......	......	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	......	......	......	......
St. Louis ‡*c*	**30.50**	**32.00**	**30.50**	**29.00**	**30.00**	**31.50**	**48.00**	*51.00*	*51.00*	73.00	72.00	13.90	16.95
San Francisco *d*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*23.00*	*23.00*	*23.00*	......	......	7.30g	8.90g
Seattle	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*25.00*	*25.00*	*25.00*	......	......	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [6] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, car load lots, delivered per 1000 sq. ft. surface. Base price — Seattle: ⅝", $70.09. ¾", $77.96. For other centers add rail freight increment from table for proper size. Add: for form oil treatment, $2.50 per M. sq. ft.; for mineral paint sealed edges, $1.00 per M; for resin dipped treatment, $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Sept. 15, 1928 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	88%*d*	88%*d*	$0.15
Baltimore	83%*d*	82%*d*	.16
Birmingham	89%	90%	.115
Boston	82%*d*	82%*d*	.16
Chicago	79%*c*	79%*c*	.16
Cincinnati	79–10%*d*	79–10%*d*	.16
Cleveland	85–10%	85–10%	.20
Dallas	80%*d*	80%*d*	.175
Denver	76%*d*	76%*d*	.16*e*
Detroit	79–10%*d*	79–10%*d*	.16
Kansas City	78–10%*d*	79–10%*d*	.165
Los Angeles	88%*a*	90%*a*	.1675
Minneapolis	76%*d*	76%*d*	.165
Montreal	70–10%*b*		.18†
New Orleans	80%*d*	80%*d*	.17
New York	82%*d*	83%*d*	.21*f*
Philadelphia	89–10%	90–10%	.16
Pittsburgh	79%*a*	79%*a*	.1525
St. Louis	86–10%	87–10%	.165
San Francisco	78%*d*	83%*d*	.165
Seattle	85%	88%	.1675

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 15, 1938 *b* Also less 6% tax exemption. *c* Discounts from jobbers list, Nov. 16, 1938. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.115	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.12 –.13	.145 –.16	.165 –.18
Rocky Mtn. States	.12 –.1425	.14 –.155**	.16 –.175**
Pacific N. W. States	.1175–.13	.1475–.16	.1675–.18
Pacific S. W. States	.1150–.1275	.145 –.1525	.165 –.1725

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

			Short Leaf	
Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6" x8" x8'		7" x 9" x8'6"	
		Untr.	Tr.	Untr.	Tr.
Boston	Oak	$1.10	....	$1.60	....
	Pine	1.30	$2.00*a*	1.95	$2.85*a*
New York	S. L. Sap Pine	1.05/1.15	1.90*g*	....	2.35*g*
	Mixed Oak	1.50	1.35	1.85	....
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	.98	....	1.35	....
	Red Oak	.98	1.48*a*	1.35	1.95*a*
	Sap Pine or Cypress.	.88	....	1.25	....
San Francisco	Douglas Fir	.80*bef*	....	....	1.85*caf*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

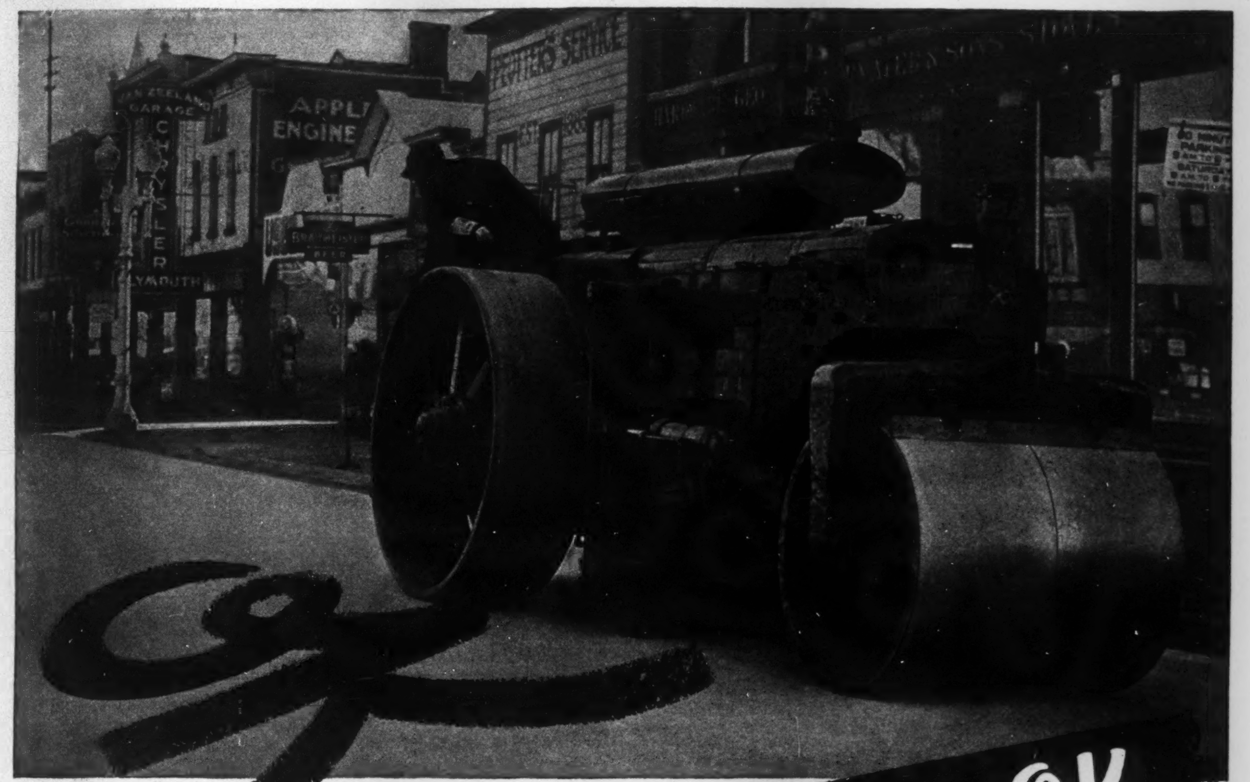
Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle. *g* Dense pine.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, per lb. delivered	.055
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.25

(Continued on page 90)



. . . and ROLLED to stay O.K.

● Smoother streets and highways of even density are the best solution to increased traffic wear with its mounting demands on your maintenance budget.

By using a Roll-A-Plane on the *subgrade*, you secure a dense, well-made foundation . . . eliminating the voids where moisture collects to cause heaving or frost boils.

By Roll-A-Planing the *base course*, the action of the center roll makes it necessary for the workmen to spread the stone evenly so that the material is not only keyed and compacted; it has surface smoothness as well. When the base is Roll-A-Plane finished, there can be no high spots to break through the wearing course and start washboarding or raveling.

Finally, for "straight edge" smoothness, use the Roll-A-Plane on the *wearing course*. With a smooth base course beneath, you are assured of an equal density at a minimum of rolling time . . . for the action of the center roll makes cross rolling unnecessary.

Ask us to describe the most recent developments in Roll-A-Plane practice, for the type of roads you are planning to build or rebuild this year.

The AUSTIN-WESTERN
ROAD MACHINERY CO., AURORA, ILL.

Motor Graders
Roll-A-Planes
Rollers
Snow Plows
Crushing and Screening Plants
Washing Plants
Blade Graders
Motor Sweepers
Shovels and Cranes
Bituminous Distributors
Elevating Graders
5-Yard Tractor-Scraper
6-Yard Tractor-Scraper
8-Yard Tractor-Scraper
12-Yard Hydraulic Scraper

(Continued from page 88)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$100.00	$120.00	$200.00	$230.00	$240.00	$250.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	195.00	250.00	300.00	13.00k	16.00k	14.00	15.00	22.00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00o	1.75o	2.25lo
Boston	90.95ab	96.95ab	181.80at	206.05ab	276.65ab	316.15a	17.00i	20.00i	20.00	13.00	2.65lp
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	16.80j	14.00j	2.75jm
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50i	13.50i	19.00	15.00	.95n
Denver	78.50	88.00	141.50	166.50	196.00	225.50	12.00	15.50	28.00j	17.00j	35.00j
Detroit	68.90	73.50	137.80	175.50	232.00	265.00e	16.00	17.00	13.50	11.25	12.75
Kansas City	64.50	66.50	86.00c	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†r	89.50†r	128.00c†r	210.00†r	368.00†r	460.00†r	12.00	14.00	16.50	.....	17.50
Minneapolis	80.35	85.70	146.00	192.85	176.20d	245.20d	13.10	15.10g	21.00	16.00	19.00
Montreal	64.00a	77.00a	141.00at	77.00a	128.00a	.....	21.00	31.00	24.60	16.00	1.75lo
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30h	238.80h	295.60h	14.00	.....	20.00	15.00	18.00
Philadelphia	77.40	82.50	154.50	185.70	229.90	284.60	11.00s	18.00s	15.50q	10.05	10.55
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.70	15.20	2.57m
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30lm
San Francisco	84.00	94.50	225.00	......	......	......	14.00	17.00	.55o	.40o	2.05m
Seattle	100.00	110.00	220.00	......	......	......	17.50f	17.50f	20.00s	20.00s	20.00s

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 15-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

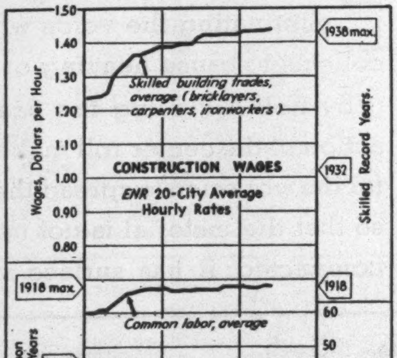
	RED LEAD	WHITE LEAD	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots f.o.b. factory				
	Per 100 lb. in. 600-lb. (Approx.) bbl. Dry *a*	Per 100 lb. in oil	Graphite *b*	Aluminum *c*	Ferric Oxide *d*	Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$8.50	$12.625	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	8.25	12.25	1.45	2.25	1.70	2.16	2.75	2.75	.40	27.50
Birmingham	8.50	12.625	2.35	2.35	1.85	2.07	2.03	2.03	.45	30.37
Boston	8.25	12.25	1.80‡	2.20‡	1.80‡	1.70‡	1.85h‡	1.85h‡	.40‡	20.00‡
Chicago	8.25	12.25	1.88	2.53	1.56	1.65hf	1.49hf	1.49hf	.25f	21.00f
Cincinnati	8.25	12.25	1.45	2.50	1.40	2.40	2.39h	2.39h	.36	21.00
Cleveland	8.25	12.25	1.90	2.60	1.40	1.45	1.50h	1.50h	.35	21.00
Dallas	8.25	13.00	1.80	1.95	....	2.75h	2.50h	2.50h	.60	....
Denver	8.75	12.75	....	....	....	2.45	4.00	3.00	.35	28.00
Detroit	8.25	12.25	2.00	3.00	1.75	2.40	3.00	3.00	.35	29.00
Kansas City	8.25	12.375	2.15g	2.40g	1.67g	1.93	2.09	2.09	.25	25.00
Los Angeles	8.50	12.75	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	8.25	12.375	....	....	....	1.45i	1.50hi	1.50hi	.29	21.00
Montreal	9.75	9.00	2.20	2.75	2.30	3.05	1.85	2.15	.95	10.80k
New York	8.25	12.25	1.80	2.45	1.48	1.50	1.50h	1.50h	.23	24.00
Philadelphia	8.25	12.25	....	....	....	1.92e	1.99he	1.99he	.41e	21.00
Pittsburgh	8.25	12.25	1.05	1.95	.80	1.95	1.94h	1.94h	.34	26.00
St. Louis	8.25	12.25	1.70/1.90	2.50/2.75	1.50/1.90	1.45	1.50	1.50	.23	21.00
San Francisco	8.50	12.50	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	8.50	12.75	1.80	3.00	2.20	2.02	1.43/2.10	2.60	.54	24.10j

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* 550 lb barrel.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.50	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40a	.30/.40a
Boston	1.50	1.375	1.50	1.375	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.625	1.70	1.025	1.025
Cincinnati	1.00/1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50	1.50	.90	.90
Dallas	1.50	1.25	1.25	1.00	1.50	.40	.40
Denver	1.50b	1.50b	1.43b	....	1.50b	.718b	.718b
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.45/.50
Los Angeles	1.25	1.10	1.375	1.125	1.50	.625	.625
Minneapolis	1.375	1.25d	1.50	1.40	1.50e	.85	.85
New Orleans	1.00	1.00	1.25	1.00	1.00	.40	.40
New York	1.886b	1.75b	1.925	2.00b	2.00c	1.031	.875/.95
Philadelphia	1.65	1.25	1.50	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75c	1.25f	1.50	1.50	1.60c	.81	.65
Seattle	1.60c	1.25c	1.50c	1.50c	1.60c	.90c	.90c
Montreal	.70	.60	.60	.55	.67	.35	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Iron workers) $1.438

ENR Common Average: $0.682